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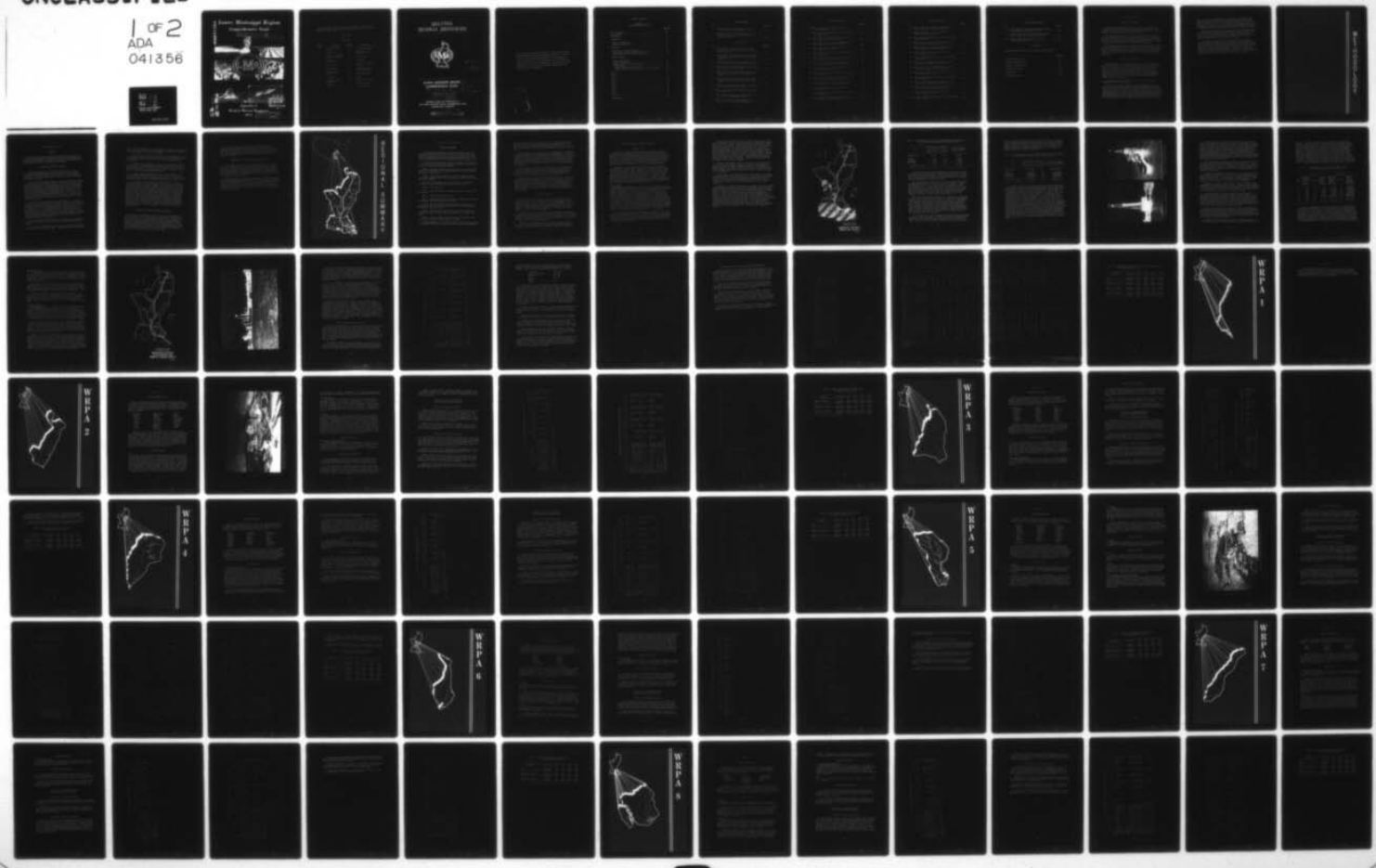

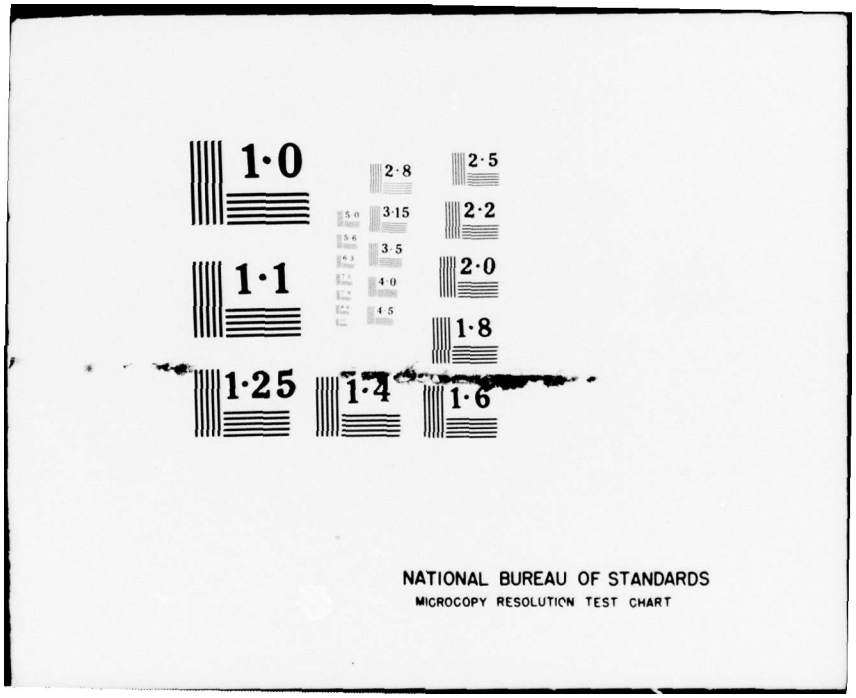
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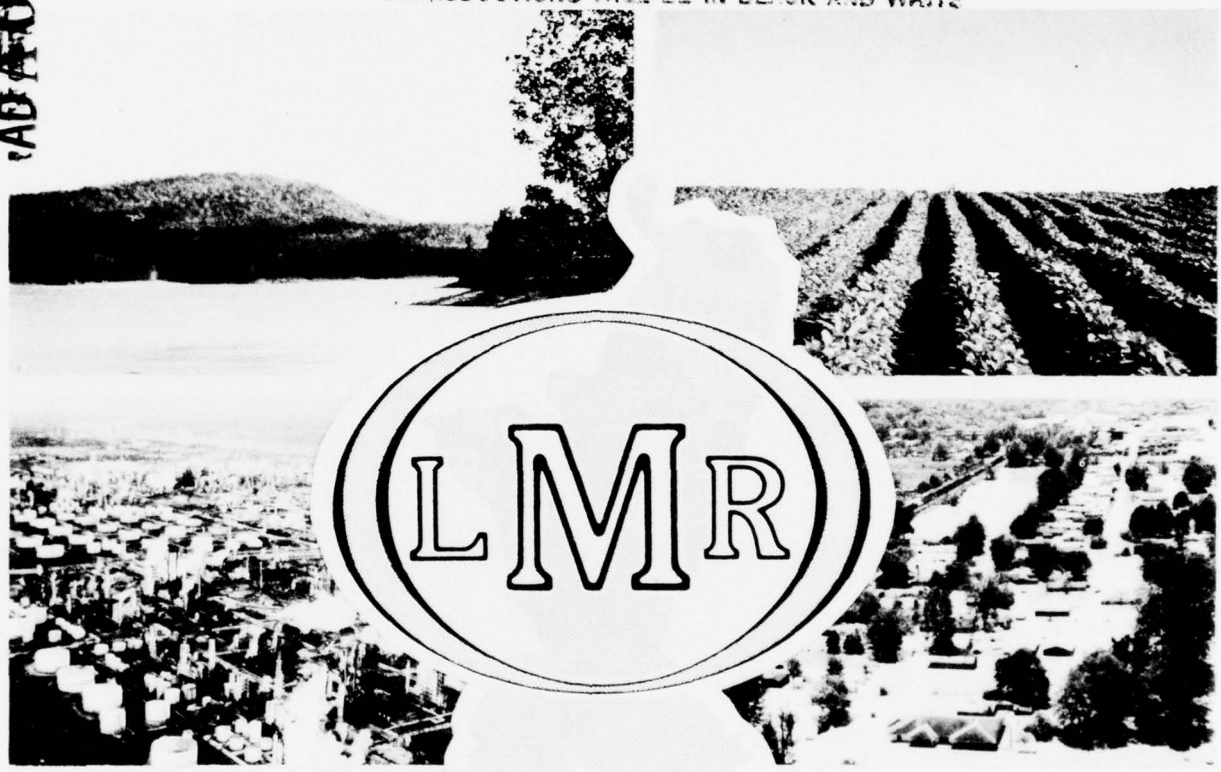
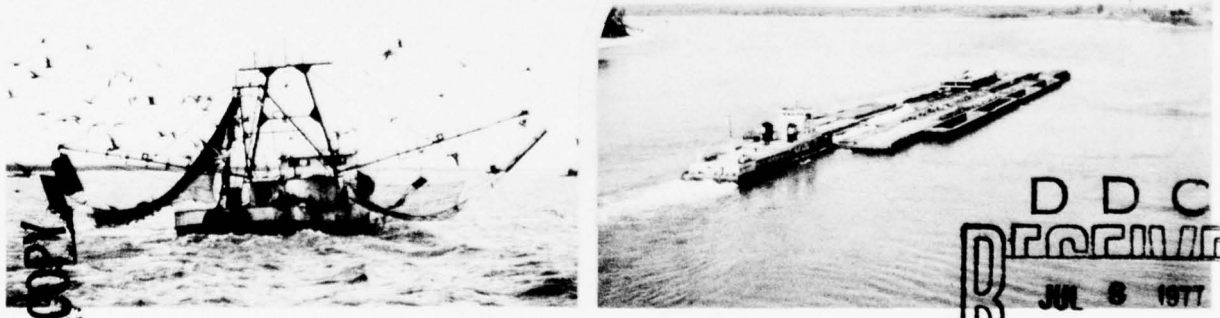
Lower Mississippi Region
Comprehensive Study





Appendix G
Related Mineral Resources
1974

This appendix is one of a series of 22 documents comprising the complete Lower Mississippi Region Comprehensive Study. A list of the documents is shown below.

Main Report

Appendixes

Appendix	Description	Appendix	Description
A	History of Study	K	M and I Water Supply
B	Economics	L	Water Quality and Pollution
C	Regional Climatology Hydrology & Geology	M	Health Aspects
D	Inventory of Facilities	N	Recreation
E	Flood Problems	O	Coastal and Estuarine Resources
F	Land Resources	P	Archeological and Historical Resources
G	Related Mineral Resources	Q	Fish and Wildlife
H	Irrigation	R	Power
I	Agricultural Land Drainage	S	Sediment and Erosion
J	Navigation	T	Plan Formulation
		U	The Environment

RELATED MINERAL RESOURCES.

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LOWER MISSISSIPPI REGION COMPREHENSIVE STUDY.

Appendix G.

PREPARED UNDER THE SUPERVISION OF
THE LOWER MISSISSIPPI REGION COMPREHENSIVE STUDY
COORDINATING COMMITTEE

This report was prepared at field level by the Lower Mississippi Region Comprehensive Study Coordinating Committee and is subject to review by interested Federal agencies at the departmental level, by Governors of the affected States, and by the Water Resources Council prior to its transmittal to the President of the United States for his review and ultimate transmittal to the Congress for its consideration.

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PHOTOGRAPHS

The photographs included in this appendix were furnished by:

I N T R O D U C T I O N

PURPOSE OF APPENDIX

Appendix G, Related Mineral Resources, is one of 21 appendixes developed for the Lower Mississippi Region Comprehensive Study. Background data required for the minerals portion of the study were compiled, reviewed, and organized during calendar years 1970-71.

The primary purpose of the estimates of mineral industry output and related water and land needs, as developed herein, is to make these basic data available to interested groups for subsequent use in regional resources evaluation and development planning within each of the broadly defined regional subdivisions of the Lower Mississippi Region.

Estimates of mineral industry production listed herein, when integrated with parallel data related to other sectors of the economy, should provide the framework needed for more detailed analysis, objective planning, and optimum development of resources--in line with established conservation principles--in the several areas of the Lower Mississippi Region.

SUMMARY AND CONCLUSIONS

Mineral industry has contributed substantially to the growth economy of the Lower Mississippi Region during the 1956-69 interval. In terms of 1967 dollars, value of mineral production was $4.6 billion in 1969, up approximately 185 percent from the $1.61 billion in 1956. Projections for the future, formulated under two sets of criteria, Program A (National Income) and Program B (Regional Development), with 1969 as the base year, indicate that the value of mineral production should increase to the $5.7-7.5 billion range by 1980, or a further advance of about 25-65 percent.

By 2020, output could vault to the $9.5-17.0 billion range, a quantum increase of 105-270 percent.

Present water needs of mineral industry are moderate; diversions and depletions in 1969 were about 675 and 171 thousand acre-feet, respectively. Anticipated efficiences in water use by the industry will be countered by the need to process lower quality raw materials--especially construction minerals--in the future; therefore, increased water requirements through 2020 will exceed increased value of mineral output by a substantial margin. Water diversions are expected to increase to about 970-1,180 thousand acre-feet by 1980, up 45-75 percent, and to attain a

range of 2,100-3,270 thousand acre-feet by 2020, up 310-480 percent. Depletions should rise to 250-330 thousand acre-feet by 1980, a 45-95 percent increase, and surge to 620-1,210 thousand acre-feet by 2020, a 260-610 percent increase. A strong expansion in secondary recovery of petroleum and pronounced growth of salt and sulfur output through 2020 are the underlying causes of this expected sharp upturn in water consumption.

Regionwide land needs for mineral production are negligible; lands in use in 1969 were approximately 66,640 acres, about 0.1 percent of the region's 65.5-million-acre total. Land needs are projected to increase to about 87-100 thousand acres by 1980, up 30-50 percent, and to 180-250 thousand acres by 2020, up 170-280 percent.

The mineral resource base in the region seems quite capable of supporting projected mineral production through 2020 in most cases. Resource limitations, however, may preclude any further increase in output of base metals from the in-region portion of the Missouri lead belt after 1980. Petroleum and natural gas (and byproduct natural gas liquids) are definite problem resources. Natural gas in particular appears certain to be in critically short supply, if not fully exhausted, in several areas within the region by the end of this century.

METHODOLOGY

METHODOLOGY

GENERAL

Projections of mineral production and mineral industry water and land needs have been made for two programs, National Income (Program A) and Regional Development (Program B). For details of methodology underlying economic projections, see Appendix B, Economics.

PROJECTIONS OF MINERAL PRODUCTION

Production and value data for minerals produced in the Lower Mississippi Region during the 1956-69 interval were used to develop regional mineral output trends. Base-year data were 1969 figures as recorded or, if not truly representative because of external influences, 1966-69 data were used.

Historic mineral production and value data are recorded on a county (or parish) basis by the Bureau of Mines. Projections, too, are based upon anticipated mineral developments within county lines rather than hydrologic boundaries. In the Lower Mississippi Region, the difference between projected mineral output within political or hydrologic boundaries is not believed to be of notable importance except in two cases. First, base metal production in Iron County, Mo., is expected to be recovered outside the hydrologic boundary of WRPA 2. And second, much offshore oil and gas is recovered at sites well removed from the lands of WRPA 9 and 10. These exceptions are noted in some detail in appropriate WRPA sections.

Value of historic mineral production traditionally is recorded in current dollars. Projected values of mineral production were developed in terms of constant 1967 dollars with values in base year 1969 adjusted according to Bureau of Mines price indexes for selected metals, minerals, and fuels. (It is noteworthy that the price index for crude petroleum was 103.7 in 1969 with 1957-59=100. Crude oil value, which represented about 60 percent of the value of mineral output in the Lower Mississippi Region during the 1960's, was essentially unchanged in terms of real dollars at the end of the decade--a striking contrast to the pronounced inflation of the period.)

Value-of-production projections for the leading mineral commodities produced in the region in base-year 1969 were developed in general as follows:

1. Value-of-production data for the 1956-69 interval were plotted on rectangular coordinate graph paper. Data points that were noticeably

out of line with other points were rechecked for accuracy, and, if still out of line, subsequently were investigated to determine the reason for the marked departure from prevailing trends.

2. Trend lines or channels were sketched on the graph paper so as to include all or almost all of the historic data, and projection lines were sketched lightly towards 2020 for an initial approximation of future output.

3. Mineral reserves and the resource base (supply) were reviewed as appropriate and were determined or assumed to be sufficient to meet all foreseeable needs through 2020, with the exception of base metals in WRPA 2 and natural gas (and byproduct natural gas liquids) in several WRPA's as noted in the individual area reviews.

4. Market requirements (demand) for pertinent commodities over the short term, commonly through 1975, 1980, or 1985, as estimated by various industry, private, or government groups, were reviewed for background data. These estimates generally were national in scope.

5. Projections of mineral fuels in the region were based upon national projections with due consideration for the region's favorable crude oil potential and possible natural gas limitation. Projections of metallic minerals in WRPA 2 and WRPA 5 were based upon reserve and resource estimates and the judgment of those familiar with the general mining districts and specific mining operations. Projections of nonmetallic minerals were based upon market opportunities. Construction minerals projections were a function of area growth as projected in basic data. Other nonmetallic minerals were projected in line with national trends for the specific commodities, with due consideration given to favorable regional factors, such as the strong resource base and competitive transportation facilities that favor growth in output of salt and sulfur in the region. Regression analysis was used to develop projections for those commodities with relatively stable production records.

PROJECTIONS OF MINERAL INDUSTRY WATER NEEDS

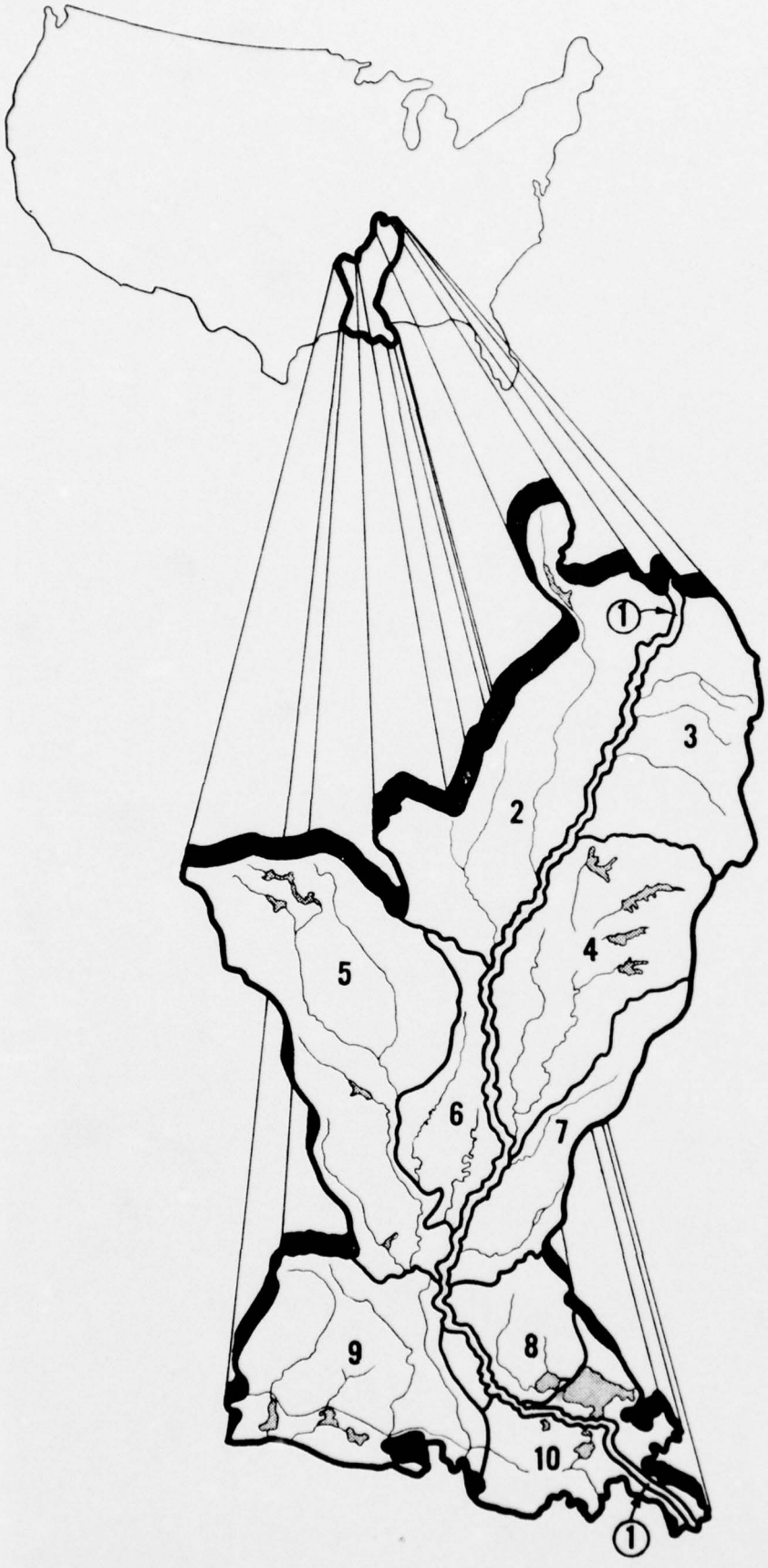
Mineral industry water-use data for 1962 were accumulated by the Bureau of Mines in a nationwide water canvass in 1963. A number of water-use studies have been performed and published by universities and by leading national research organizations that contain substantial sections on mineral-commodity and mineral-industry water use. These sources of information have been reviewed in determining base-year use and estimating future water needs by mineral industry; the basic sources of essentially all data finally used in development of projections, however, were Bureau of Mines water canvass data.

Two factors--a diversion factor and a depletion factor--were developed for the important mineral commodities in each area. Each factor indicated water needs in gallons per (1967) dollar value of mineral output. Subsequently, the volume of water required was converted into acre-feet, and all water needs in this report are expressed in terms of acre-feet.

PROJECTIONS OF MINERAL INDUSTRY LAND NEEDS

Mineral industry land-use data are not requested by the Bureau of Mines in its annual canvass of mineral industry activities. However, land-use data have been included in descriptions of mineral properties presented in many Bureau publications, some reports and maps of the U. S. Geological Survey, and some technical journals. These data have served as the basis for estimating land use at the larger mineral industry operations in base-year 1969.

Surface land use at the numerous small mineral industry operations was estimated. Minerals recovered from vein-type deposits usually involve only negligible land use whereas, in contrast, sedimentary mineral deposits recovered by surface-mining methods commonly require a substantial land area even for relatively small operations. Based upon prior studies, oil and gas wells were estimated to occupy an average of one-third acre per well.



REGIONAL SUMMARY

REGIONAL SUMMARY

PHYSICAL ENVIRONMENT

The Lower Mississippi Region includes the drainage area of the Mississippi River below the mouth of the Ohio, except for the White, Arkansas, and Red Rivers above the effects of Mississippi River backwater; the Louisiana coastal area between the drainage divides of the Pearl and Sabine Rivers; and the flood protected area at Cairo, Ill.

To provide a practical basis for plan formulation, the region has been divided into the following hydrologic areas that are referred to as water resource planning areas or WRPA's:

WRPA 1. The main stem of the Mississippi River below the mouth of the Ohio, extending to and including the levees or to the top bank where levees do not exist.

WRPA 2. The St. Francis Basin, St. Johns-New Madrid Floodway, Lower White, and Bayou Meto Basins, including the Arkansas River below Pine Bluff, Arkansas.

WRPA 3. The drainage basins of west Kentucky, west Tennessee, extreme northern Mississippi, and the Cairo, Illinois area.

WRPA 4. The Yazoo Basin.

WRPA 5. The Ouachita Basin, including the Lower Red River below Hot Wells, La.

WRPA 6. The Boeuf and Tensas Basins.

WRPA 7. The Big Black Basin and basins of southwest Mississippi streams that drain into the Mississippi River.

WRPA 8. The Baton Rouge area, including the drainage area of streams that flow into Lake Pontchartrain except for the Tchefuncta River and streams to the east.

WRPA 9. The Louisiana coastal area from the east limits of the Atchafalaya Floodway to east hydrologic boundary of the Sabine River Basin.

WRPA 10. The New Orleans areas, including the Tchefuncta River area and the area east of the Atchafalaya Floodway.

Economic boundaries of the region include 161 parishes and counties in Louisiana, Mississippi, Arkansas, Tennessee, Missouri, and Kentucky,

and the flood protected area at Cairo, Ill. The region stretches about 600 miles from the northernmost Missouri County south to the Gulf of Mexico and spans east-west a maximum width of about 315 miles. The area of the region is approximately 105,000 square miles or 65.5 million acres.

Mineral industry statistical data are compiled herein by traditional counties and parishes rather than by hydrologic boundaries. Generally this procedure does not prove troublesome; however, there are two notable exceptions. First, all base metal mining in Iron County, Mo., is outside of the hydrologic boundary. Second, much of the very substantial offshore oil and gas production is recovered beyond the 3-mile limit, but such output is credited statistically to the several Louisiana Gulf Coast parishes.

Mineral production from WRPA 1, the main stem of the Mississippi River, is credited to the nearest county or parish; therefore, WRPA 1 is not specifically considered herein. Mineral output from WRPA 1, such as sand, gravel and clay, as well as subsurface oil and gas, is included in other appropriate WRPA mineral data summaries.

Approximately one-third of the region is made up of the flat and extremely fertile alluvial valley of the Mississippi River. The remaining area varies from the gentle relief of the Bayou Meto and Grand Prarie area to the more rugged mountainous area in the Ouachita Basin. Detailed descriptive data on the region's physical environment may be found in Appendix C, Regional Hydrology and Geology, in Appendix F, Land Resources, in Appendix O, Coastal and Esturine, and in Appendix T, Plan Formulation.

ECONOMIC ENVIRONMENT

Mineral production, manufacturing, and agriculture are the three major sectors of economic activity in the Lower Mississippi Region. Petroleum, natural gas, and sulfur were the leading minerals in terms of value of output in 1969. Leading manufacturing industries were chemical and allied products, food and kindred products, and petroleum refining. Leading agricultural products were soybeans, rice, corn, cotton, beef, pork, fowl, eggs, and milk.

Population of the region in 1970 was approximately 6.29 million, up from 5.83 million in 1960 and 5.55 million in 1950. In 1968, regional personal income amounted to $15.4 billion in 1967 dollars, or $2,447 per capita. Earnings in 1967 dollars were $12.3 billion in 1968, or $5,550 per worker, for the 2.2 million employed.

Moderate to substantial growth is visualized for all sectors of the regional economy through 2020. Detailed descriptive data on the region's economic environment may be found in Appendix B, Economics.

MINERAL RESOURCES, INDUSTRY, AND NEEDS

Resource Base

Projections of mineral output, to be meaningful, must be based upon factual data quantifying in some degree available mineral reserves and resources. By definition, mineral reserves are those resources that have been investigated and delineated by generally accepted methods, and that have been proven to exist in the quantity and grade required to satisfy a fairly definite market demand. Mineral resources, on the other hand, are assumed to exist on the basis of geologic projection and may be used in the future to satisfy a presumed market demand.

Ordinarily it is not realistic to develop reserve data beyond certain limits, depending upon a number of technical and economic considerations for specific mineral commodities. Available reserve data for most of the mineral resources produced in the region are not sufficient to support 50-year projections of output. Often such mineral reserve data are held confidential by those in the industry who have developed the information at substantial cost. Therefore, mineral resource data, which are more generalized and are based upon production records, reserve data, geologic information, and broad assumptions, are used to develop the mineral resource base herein.

Mineral Fuels

Petroleum and natural gas. Reserve data for oil and gas are disturbing when viewed in the light of domestic annual production-consumption trends. On December 31, 1969, oil reserves were about 29.6 billion barrels (excluding the recent Alaskan North Slope discoveries), or enough to supply about 8.8 years of output at the 3.37-billion-barrel rate of production in 1969. Similarly, natural gas reserves were 275 trillion cubic feet, enough to provide about 13.2 years of gas supply at the 20.9-trillion-cubic-feet rate of production in 1969. Considering recent annual growth rates in the demand for oil and gas, which are on the order of 3 and 6 percent respectively, the reserve figures are even more alarming. Somewhat comforting considerations include the alternative mineral fuels, such as coal and uranium, synthetic potential based upon coal, oil shale, and tar sands, and the promise of an increased percentage recovery from known and probable discoveries of oil and gas.

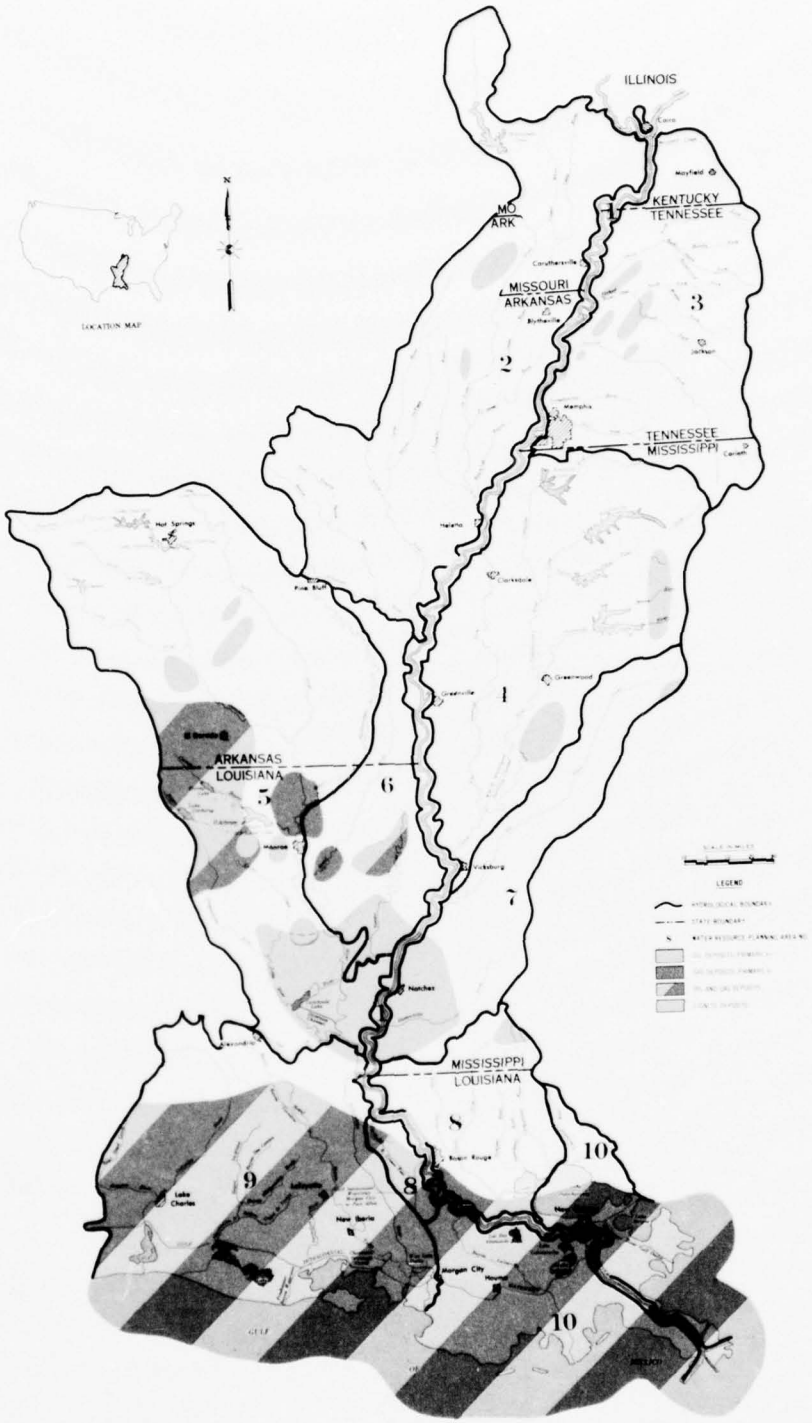
This apparent squeeze upon limited mineral resources, such as oil and gas, has stimulated the study of "ultimate" recoveries. One of the more recent studies, which seems to strike a median range, was developed by T. A. Hendricks of the U.S. Geological Survey and has served as the foundation for projections of oil and gas output developed herein for the Lower Mississippi Region.

Hendricks estimated that a total of 1,600 billion barrels of crude oil was originally in place in the United States. Through 1960, approximately 400 billion barrels had been discovered, leaving 1,200 billion barrels still to be found. (Updated to the 1969 base year, the figures would be approximately 425 and 1,175 billion barrels, respectively. All subsequent figures are updated through 1969.) Hendricks estimated that only about 1,000 billion barrels of the original resource can be developed profitably. Further, the ultimate recovery median is assumed to be 75 percent, or 750 billion barrels. (Secondary recovery and reworking of older fields are included.) Cumulative production through 1969 was 88 billion barrels; therefore, about 660 billion barrels of recoverable crude oil remain in place.

Using the 1969 domestic output of crude oil as a base and allowing for 3 percent annual growth in output (a commonly used assumption), cumulative domestic production through 2020 would be approximately 525 billion barrels. The domestic resource base, then, seems sufficient to support demand through 2020, provided that future discoveries are made in a timely manner.

Reserve data are not available for the several WRPA's in the Lower Mississippi Region. Data are available by State, however, and assuming a national reserve-resource relationship may be broken down into a state-by-state reserve-resource relationship, then it may be possible to develop an indication of oil and gas potential for the region (figure 1).

Cumulative oil production would reach a maximum level of 110 billion barrels through 2020 in the Lower Mississippi Region, an estimate computed by using somewhat more conservative annual growth rates of approximately 1.2 percent for Program A and 2.7 percent for Program B. This estimate is about 21 percent of projected national output for the period. In the 1960's the Lower Mississippi States produced about 25 percent of total national crude oil output--and essentially all of this output was from the Lower Mississippi Region. Reserves for the region were 20.8 billion barrels on December 31, 1969. If the reserve-resource relationship prevails on the regional level, the resource base in the region is 137 billion barrels and, therefore, capable of supporting projected oil production through 2020. These data are summarized in table 1.



LOWER MISSISSIPPI REGION
COMPREHENSIVE STUDY

GENERALIZED LOCATION OF MINERAL FUEL DEPOSITS

FIGURE 1

Table 1 - Proved Crude Oil Reserves and Estimated Crude Oil Resources in the Lower Mississippi Region, December 31, 1969

Area	Proved Crude Oil Reserves		Crude Oil Resource, million barrels
	million barrels	percent	
United States	29,632	100	660,000
Arkansas	127	0.4	2,640
Louisiana	5,689	19.2	126,720
Mississippi	360	1.2	7,920
Lower Miss. Region	6,176	20.8	137,280

A widespread thick section of sedimentary rocks underlies most of the region, except for some limited outcrops of igneous rocks in southeast Missouri and central Arkansas. Such sedimentary deposits, considered in conjunction with certain other geologic features, offer promise of containing economic oil and gas resources.

The following data are pertinent to a parallel analysis based upon the Hendricks review of the Nation's natural gas potential. Natural gas originally in place in the United States is estimated at 4,000 trillion cubic feet. Of this volume, 2,500 trillion cubic feet can be found and developed profitably, and about 90 percent or 2,250 trillion cubic feet can be recovered. Through 1969, about 350 trillion cubic feet has been wasted (in earlier years) or marketed. The resource remaining, therefore, is about 1,900 trillion cubic feet.

Based upon 1969's marketed output of 20.7 trillion cubic feet, the resource base would last about 90 years at the 1969 rate of consumption. Growth in output would have to be limited to slightly less than 2 percent annually if the resource base is to provide natural gas through 2020. Although annual growth in marketed gas has been around the 6-percent rate in recent years, it is now widely believed that conventional natural gas output has reached a plateau. Further increases in domestic supplies, therefore, must be obtained from imports (both overland pipeline gas and overseas liquefied gas) and from conversion of coal and other hydrocarbons into gas.

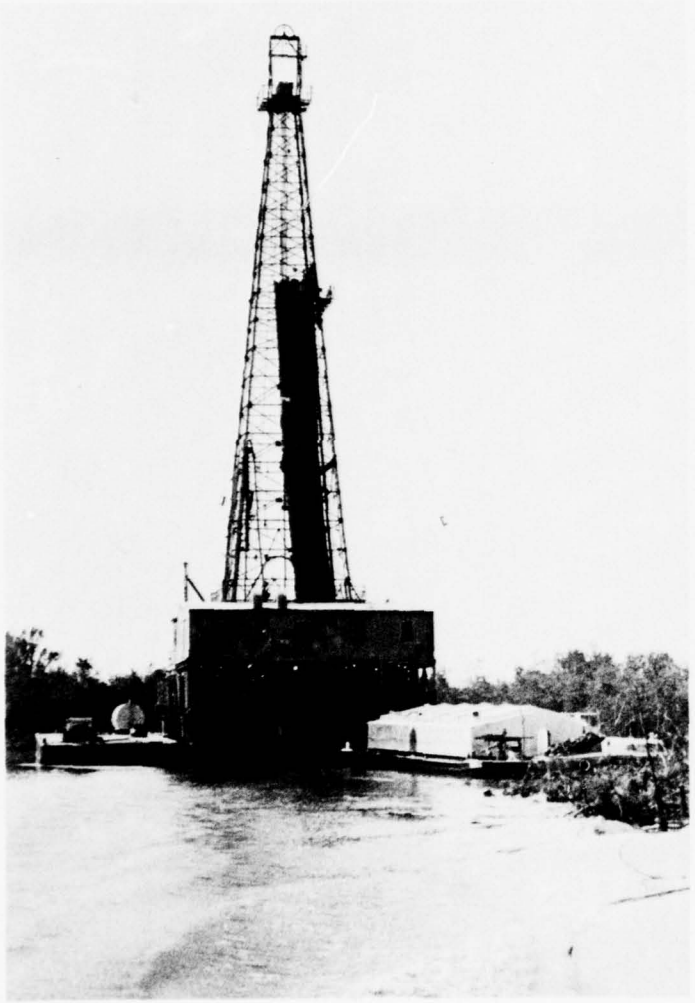
In the 1960's, the Lower Mississippi Region provided about one-third of domestic natural gas output. (Production actually increased uninterruptedly from 25 percent of national output in 1960 to 36 percent in 1969.) Because of this exceptional production record and the inviting

geologic conditions throughout most of the region, it seems reasonable to expect further growth in natural gas output. Projections, therefore, indicate some growth--somewhat less than 1½ percent for Program A and about 2 percent for Program B--through 2020. Data for natural gas are summarized in table 2, using the same approach as in developing the reserve-resource distribution for crude oil.

Table 2 - Proved Natural Gas Reserves and Estimated Natural Gas Resources in the Lower Mississippi Region, December 31, 1969

Area	Proved Natural Gas Reserves		Natural Gas Resource, million cubic feet
	million cubic feet	percent	
United States	275,000,000	100	1,900,000,000
Arkansas	2,630,000	1.0	19,000,000
Louisiana	85,060,000	30.9	587,000,000
Mississippi	1,410,000	0.5	10,000,000
Lower Miss. Region	89,100,000	32.4	6 16,000,000

If natural gas output in the Lower Mississippi Region increases at about 2 percent annually, the cumulative production through 2020 would be about 650 trillion cubic feet, or approximately 6 percent more than the estimated resource of 616 trillion cubic feet listed in table 2. Considering the methodology used to determine the resource, this is not a matter of grave concern. However, there is one additional factor related to future oil and gas production in the region that is noteworthy, and that is offshore production. Most of the offshore oil and gas has been produced within 50 miles or so of the Louisiana coast. Essentially all of this output has been piped to onshore oil refineries and natural gas processing plants in southern Louisiana, and subsequently distributed through product pipelines to in- and out-of-State markets. Future oil and gas likely will be recovered at increasing distances southward from the Louisiana coast as known fields are extended and further discoveries are made. Increasing the distance to offshore production also expands greatly the array of variables and unknowns, introducing complexities that preclude any firm or well founded consideration of remote offshore output in projections of mineral production in the Lower Mississippi Region. Some of these imponderables are discussed briefly below.



Oil drilling rig at Bayou Sale, La.

Offshore oil drilling rig and tender.

A casual scanning of a map of the Gulf of Mexico reveals that as crude oil discoveries are made farther south of the Louisiana coastline an area is reached where crude may be piped a shorter distance westward to the Texas coast. Refining facilities in east Texas were under less pressure from increasing in-State output of crude during the 1960's. (Crude oil output in Texas increased from 930 million barrels in 1960 to 1,150 million barrels in 1969, a 24-percent increase, whereas in Louisiana output jumped from 400 to 840 million barrels for a 110-percent increase during the same time interval.) Therefore, it is quite likely that some of the anticipated remote offshore oil may be directed to and processed in Texas in future years.

Another reasonable conclusion is that natural gas from remote offshore areas could be directed eastward to the Florida coast. Natural gas processing facilities are considerably less capital intensive than petroleum refineries; therefore, a substantial saving in transport cost could materialize by piping gas directly to the Florida area for processing and marketing.

An underlying assumption in both concepts is that the floor of the Gulf of Mexico is conducive to the laying of long-distance pipelines generally east and west. An alternative, if needed, could be offshore tanker loading of crude oil (and possibly liquefied natural gas) for shipment to the northeast States for refining and marketing.

Eventually, of course, remote southern offshore production areas could impinge on Mexican Territorial waters. Moreoever, with respect to jurisdiction, it has been proposed in some quarters to invest ownership in or to arrange for some form of royalty payments from seabed resources to the United Nations to help meet its financing needs.

In any event, such variables and unknowns preclude precise or meaningful estimations of the future impact of remote offshore oil and gas production upon the development of the Lower Mississippi Region. However remote the seaward limits of production may become by 2020, it is likely that offshore output will continue to have some impact upon the economy of the region--in such sectors as employment and related service industries, for example--but the impact upon the region's water and land resources seemingly will become negligible.

Offshore oil and gas, then, probably will make a significant contribution to total Lower Mississippi Region energy output through much of the remainder of the century. Beyond 2000, however, the impact of the more distant offshore production is exceedingly difficult to estimate and therefore, such probable output is given only general consideration in the 2000-2020 projection interval.

Distribution of the resource potential of the region among the several WRPA's is based upon their oil and gas output during the 1956-69

interval. Oil and gas output in the Lower Mississippi Region (the hydrologic region) represents about 90 percent of the output from the six Lower Mississippi States. Northwest Louisiana, southwest Arkansas, and eastern Mississippi are the noteworthy out-of-region production areas in the Lower Mississippi States. Considering the elementary approach in developing the distribution of resource potential among the WRPA's, this small percentage difference does not seem significant. Potential probably has been understated in the northern part of the region where exploration has been limited, as well as in the offshore areas where ultimate distance from coastline is not readily definable. Nevertheless, the oil and gas potential for the WRPA's is believed to be indicative of actual production capability, at least for the next decade or two. Resource potential is distributed among the WRPA's in table 3.

Table 3 - Estimated Oil and Gas Potential in WRPA's in the Lower Mississippi Region, December 31, 1969

	Crude Oil			Natural Gas		
WRPA	Cumulative Production 1956-69, million barrels	Percent	Resource Distribution million barrels	Cumulative Production 1956-69, million cubic feet	Percent	Resource Distribution, million cubic feet
4	30	0.4	550	500	-	1,000,000
5	406	5.5	7,550	2,778,000	5.4	33,000,000
6	201	2.7	3,710	747,000	1.4	8,500,000
7	124	1.7	2,330	217,000	0.4	2,500,000
8	201	2.7	3,710	662,000	1.3	8,000,000
9	1,997	27.0	37,070	27,671,000	53.3	328,000,000
10	4,451	60.0	82,360	19,813,000	38.2	235,000,000
LMR	7,410	100	137,280	51,889,000	100	616,000,000

Lignite. Widespread but discontinous deposits of lignite occur in northern Louisiana, southern and eastern Arkansas, western Mississippi, and western Tennessee (figure 1). There are no lignite operations in the region; it is noteworthy in recent years, however, that similar lignite deposits in east Texas have been developed for use in electric power generation and for some limited use in the chemical industry. It seems probable that some of the lignite resources in the region will be developed through 2020, but it is impossible even to approximate the location of such developments because of limited resource and related information.

Metallic Minerals

Metallic mineral resources have been produced in important quantities in southeast Missouri and central Arkansas (figure 2). Although reserved data are limited and are frequently held confidential, the near-term future is virtually certain to be marked by some growth in output. Beyond 1980, output may level off, but it should be sustained on a high plateau through 2020.

Base metals (lead, zinc, and copper) and iron ore are produced in southeast Missouri. Byproducts include silver and periodically some minor amounts of nickel and cobalt. Production trends, reserve data, and the geologic environment all suggest that the resource base probably is strong enough to support the output projections in WRPA 2.

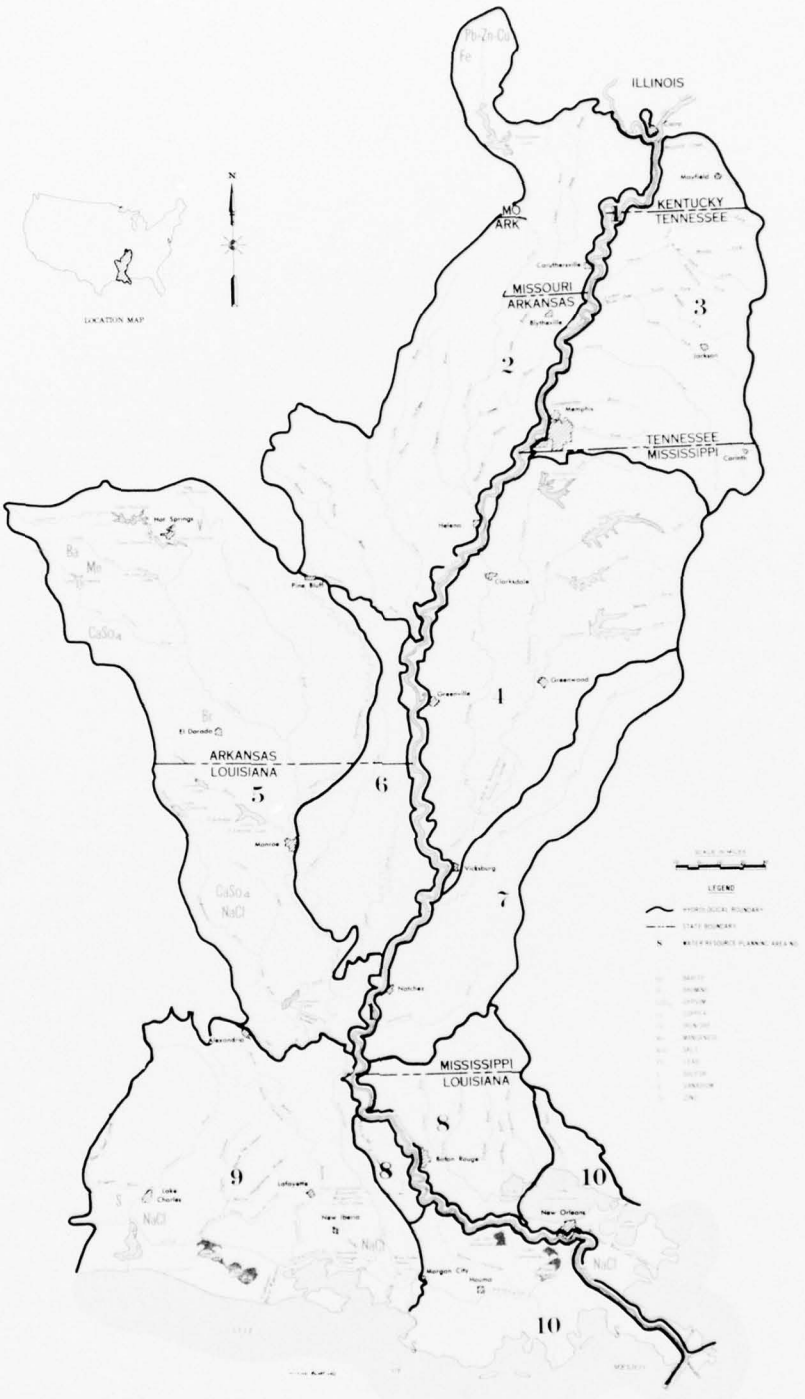
Vanadium is produced in Garland County, Ark., in WRPA 5. The vanadium ore is associated with alkaline igneous rocks and is unique in this respect in the Nation. Information is limited; it is assumed, however, that the resource base will prove capable of supporting the modest production of this ferroalloy, possibly with some growth, through 2020.

Nonmetallic Minerals

Construction minerals. A number of the more common construction minerals--sand, gravel, stone, gypsum, and clays--are found in the region. Although quality problems exist, sand and gravel deposits are widespread. Stone, gypsum, and clays are more localized, but usually occur in large deposits. Access to these low value minerals is a matter of concern, and the slowly declining quality of some of these resources is a growing problem. Reserve data are sparse; in general, however, the resource base for most of the important construction minerals is huge.

Barite. Barite deposits are found in the Arkansas part of WRPA 5 (figure 2). Much of the regional production is used in preparing drilling mud for the petroleum industry, and future demand is expected to keep pace with exploration for and development of regional oil and gas deposits. Reserve data are limited, but the geologic environment suggests that the resource potential in the region is ample to support the moderate production projected through 2020.

Bromine. Bromine is extracted from brines found in the Smackover limestone (of Jurassic age) in the Arkansas section of WRPA 5 (figure 2). The resource base is believed to be sufficient to support the moderate growth in output projected through 2020. Bromine is used to manufacture ethylene dibromide, a fuel additivie for gasoline engines. Used as a scavenger of combustion products (mainly lead), this principal market for bromine is in jeopardy because of the transitional status of gasoline additives. Nevertheless, markets are growing in the chemical and photographic industries, and some increase in output is anticipated.



LOWER MISSISSIPPI REGION
COMPREHENSIVE STUDY

GENERALIZED LOCATION OF SELECTED METALLIC AND NONMETALLIC MINERAL DEPOSITS

FIGURE 2

Bromine extraction plant in Union County, Ark.

Salt. Louisiana has been the Nation's leading salt-producing State in recent years. Salt domes in southern Louisiana are immense and numerous. The resource base is essentially inexhaustible (figure 2). Salt is a widely used mineral in the chemical and food industries, and rock salt is used for snow and ice removal and roadbed stabilization. In 1969 domestic production was 44.2 million tons. The chemical industry used over two-thirds of the output to make chlorine, caustic soda, soda ash, and other chemicals.

Salt is a commonplace mineral and is produced annually in 16 to 20 States. About 85 percent of domestic production is recovered in Louisiana, Texas, Ohio, New York, and Michigan. Substantial output is noted in industrial areas in close proximity to the Great Lakes near Cleveland, Ohio, in western New York State, and from an underground mine in Detroit, Mich. The winter shutdown of shipping on the Great Lakes is a regional handicap to the low-cost transport of low-value, high-bulk salt. In contrast, the advantageous coastline location of Louisiana salt deposits should be a stimulant to exceptional growth in salt production for much of the East Coast market.

Sulfur. Louisiana also has been the Nation's leading sulfur-producing State in recent years. Sulfur is produced by the Frasch process from both inshore and offshore deposits (figure 2). The sulfur is associated with salt domes and, although the occurrence of economically recoverable sulfur deposits is not commonplace, the resource base in the geologically favorable Gulf Coast environment would seem to be sufficient to supply projected output through 2020. Of the 9.2 million long tons of sulfur used in the Nation in 1969, approximately half was consumed in the production of fertilizers. The remaining half found widespread use in many varied industries--so much so that sulfur consumption is a reliable indicator of industrial activity.

Mineral Production and Projections

Value of mineral production in the Lower Mississippi Region amounted to $4.75 billion in 1969, up from $1.29 billion in 1956. This value represented about 18 percent of the Nation's $26.9 billion in mineral output in 1969, up from 7 percent of the Nation's $17.3 billion in output in 1956. These data are in current dollars and are detailed in table 4. The table lists the mineral commodities produced in the region, unit of production, and quantity and value for the years 1956, 1963, and 1969. Total quantity and value data for the years 1956-69 inclusive also are listed.

The economic importance of mineral industry to the region is obvious. Less evident is the vital importance of regional mineral output to the Nation. The following list of important minerals, presenting the percent of national output produced in the region in 1969, points up the

Table 4 - Lower Mississippi Region, Mineral Production, 1956, 1963, 1969, and Total 1956-1969
(Values in thousand current dollars)

Commodity, unit of production	1956		1963		1969		Total, 1956-1969	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Abrasives[1/] ..... short tons	151	$37	W	W	W	W	W	W
Barite ..... do	486,254	4,256	W	W	W	W	3,844,652	$38,280
Bromine ..... thousand pounds	0	0	W	W	W	W	555,331	75,725
Cement:								
Masonry ..... 280-pound barrels	W	W	W	W	W	W	W	W
Portland ..... thousand 376-pound barrels	W	W	W	W	W	W	W	W
Clays ..... short tons	2,058,464	7,109	1,742,403	$7,451	2,147,423	$10,248	26,278,072	107,588
Copper[2/] ..... do	1,065	905	177	109	W	5,205	14,088	11,230
Gem stones ..... pounds	NA	25	8,093	42	NA	24	NA	545
Gypsum, crude ..... short tons	W	W	W	W	W	W	3,021,151	8,290
Iron ore (usable) ..... thousand long tons	3	17	65	447	W	W	1,398	18,255
Lead[2/] ..... thousand short tons	14	4,260	16	3,529	104	30,902	311	86,787
Lime ..... short tons	W	W	W	W	W	W	W	W
Mercury ..... 76-pound flasks	0	0	0	0	0	0	350	170
Natural gas ..... million cubic feet	1,614,715	184,146	3,631,646	718,405	6,936,582	1,331,751	51,888,791	9,290,770
Natural gas liquids ..... thousand barrels	20,436	60,636	46,839	106,574	119,299	252,938	710,241	1,697,697
Petroleum ..... do	295,154	906,481	514,682	1,603,911	853,934	2,816,982	7,679,835	23,442,427
Salt ..... thousand short tons	W	W	W	W	12,435	61,102	89,995	459,436
Sand and gravel ..... do	17,145	17,692	19,395	20,791	28,998	35,261	287,327	325,370
Silver[2/] ..... troy ounces	3,006	3	41,904	54	501,563	W	871,455	1,382
Stone ..... thousand short tons	5,338	8,581	5,941	8,823	13,160	17,662	89,104	132,000
Sulfur, Frasch ..... thousand long tons	W	W	2,445	48,905	3,999	108,299	40,624	1,070,471
Vanadium ..... short tons	0	0	0	0	W	W	W	W
Zinc[2/] ..... do	0	0	0	0	15,362	4,486	20,776	6,017
Total		1,288,021		2,584,008		4,750,642		37,174,268

NA Not available. W Withheld to avoid disclosing company confidential information.
1/ Includes tripoli.
2/ Recoverable content of ores.

vital contribution of regional mineral industry to national mineral demands. (Fractions are used to approximate the region's share of national output when company confidential information is involved.)

Natural gas	34 percent
Natural gas liquids	31 do.
Petroleum	25 do.
Lead	20 do.
Bromine	1/5
Salt	1/3
Sulfur	2/3

Based upon reserve data, developing mineral projects, and on-going exploration efforts, increased output of all minerals produced in the Lower Mississippi Region is virtually assured through 1980. Beyond 1980, however, resource problems are evident. Natural gas (and associated natural gas liquids) is probably the best example. If substantial gas discoveries are made offshore, at greater depths in Louisiana, and in WRPA's 2, 3, and 4, then projected output through 2020 is quite possible. These discovery assumptions, however, are quite demanding, and the possibility of a deficient natural gas resource base after 2000 must be weighed. Crude oil output in some of the older producing districts, such as southwest Arkansas, may decline somewhat more than anticipated, too.

Production of metallic minerals in southeast Missouri probably will expand through 2020. WRPA 2 is only partially within this district, however, and it is unlikely to share fully in the district's increased output.

Although nonmetallic minerals available present quality problems in some parts of the region, the resource base appears to be adequate.

In summary, the mineral resource base is generally believed to be capable of supporting most projected mineral output through 2020. A parallel assumption is that access to land and suitable incentives will spur mineral industry exploration and development efforts in the region.

Base-year production and value by mineral commodity and mineral group and projections for the years 1980, 2000, and 2020 are listed in table 5. The appropriate unit of production for each mineral is indicated, and all value data are in terms of 1967 dollars.

At the Program A and B levels of estimated production through 2020, mineral fuels output would increase about 100-260 percent, metallic minerals 75-130 percent, nonmetallic minerals 230-390 percent, and total minerals 110-270 percent. For individual minerals the most pronounced growth in output is expected to be that of salt, up 560-620 percent, followed by sulfur, up 245-500 percent.

Table 5.--Lower Mississippi Region, Mineral Production and Value, 1969, and Projections for 1980, 2000, and 2020
(Thousand 1967 dollars adjusted by Bureau of Mines price indexes for selected minerals)

Commodity, unit of production	Projection	1969 Production	1969 Value	1980 Production	1980 Value	2000 Production	2000 Value	2020 Production	2020 Value
Fuels:									
Natural gas............million cubic feet..	Program A..	6,937,000	$1,287,191	8,579,000	$1,595,596	11,261,000	$2,141,806	14,092,200	$2,680,597
Do..................................do....	Program B..	6,937,000	1,287,191	9,672,000	1,795,182	14,365,000	2,666,155	18,772,000	3,485,914
Natural gas liquids......thousand barrels..	Program A..	119,299	297,067	168,242	418,908	246,686	614,250	326,186	815,430
Do..................................do....	Program B..	119,299	297,067	197,853	492,649	323,144	804,702	449,550	1,119,368
Petroleum...........................do....	Program A..	855,934	2,658,882	1,017,230	3,160,891	1,298,535	4,035,352	1,589,763	4,941,783
Do..................................do....	Program B..	855,934	2,658,882	1,455,081	4,528,616	2,428,134	7,557,117	3,464,926	10,783,557
Summary, fuels..............................	Program A..		4,243,140		5,175,195		6,791,457		8,435,630
Do..	Program B..		4,243,140		6,816,447		11,027,932		15,386,839
Metallic minerals:									
Copper1/.....................short tons..	Program A..	W	W	10,500	8,158	10,500	8,158	10,500	8,158
Do..................................do....	Program B..	W	W	11,500	8,912	13,170	10,200	13,170	10,200
Iron ore (usable)......thousand long tons..	Program A..	W	W	1,556	12,706	1,556	12,706	1,556	12,706
Do..................................do....	Program B..	W	W	1,584	14,842	1,584	14,842	1,584	14,842
Lead1/...............thousand short tons..	Program A..	104	29,328	100	56,118	200	56,400	200	56,400
Do..................................do....	Program B..	104	29,328	218	61,476	250	70,500	250	70,500
Silver1/............thousand troy ounces..	Program A..	502	1,074	900	2,054	900	2,054	900	2,054
Do..................................do....	Program B..	502	1,074	1,032	2,351	1,200	2,600	1,200	2,600
Vanadium.....................short tons..	Program A..	W	W	1,000	3,080	1,000	3,080	1,000	3,080
Do..................................do....	Program B..	W	W	1,500	4,620	2,000	6,160	3,000	9,240
Zinc1/..............................do....	Program A..	15,362	4,286	29,388	8,193	30,000	8,370	30,000	8,370
Do..................................do....	Program B..	15,362	4,286	32,200	8,984	37,000	10,323	37,000	10,320
Summary, metallic minerals..................	Program A..		51,400		98,205		98,748		98,748
Do..	Program B..		51,400		101,085		114,622		117,792
Nonmetallic minerals:									
Abrasives2/..................short tons..	Program A..	W	W	7,500	344	7,000	308	6,900	472
Do..................................do....	Program B..	W	W	8,000	580	8,000	580	8,000	580
Barite, crude.......................do....	Program A..	W	W	215,800	4,317	250,250	5,005	227,800	5,239
Do..................................do....	Program B..	W	W	204,000	6,776	434,700	9,938	575,500	13,236
Bromine..................thousand pounds..	Program A..	W	W	90,183	21,644	122,562	29,415	154,383	37,052
Do..................................do....	Program B..	W	W	107,060	25,694	170,804	40,993	235,068	56,432
Cement:									
Masonry..............280-pound barrels..	Program A..	W	W	277,180	703	325,020	826	396,575	1,007
Do..................................do....	Program B..	W	W	295,060	749	364,801	927	453,083	1,151
Portland.....thousand 376-pound barrels..	Program A..	W	W	8,087	25,727	9,644	30,637	11,910	37,935
Do..................................do....	Program B..	W	W	8,508	27,354	10,725	34,128	13,538	43,106
Clays........................short tons..	Program A..	2,147,423	7,720	2,827,850	11,872	4,074,681	20,818	5,682,716	31,794
Do..................................do....	Program B..	2,147,423	7,720	3,060,961	12,713	4,647,487	23,466	6,621,019	36,343
Gem stones.......................pounds..	Program A..	NA	55	NA	55	NA	55	NA	55
Do..................................do....	Program B..	NA	55	NA	55	NA	55	NA	55
Gypsum, crude................short tons..	Program A..	W	361	185,570	381	217,917	681	264,165	829
Do..................................do....	Program B..	W	361	197,255	719	248,685	755	305,305	958
Lime................................do....	Program A..	W	W	909,267	11,552	1,097,567	13,709	1,357,801	16,071
Do..................................do....	Program B..	W	W	977,020	12,198	1,230,359	15,476	1,555,141	19,432
Salt.................thousand short tons..	Program A..	17,435	66,568	43,948	99,456	43,508	216,923	69,095	348,971
Do..................................do....	Program B..	17,435	66,568	21,002	109,204	53,828	268,375	89,941	418,427
Sand and gravel.....................do....	Program A..	28,998	34,157	31,051	36,442	37,231	43,151	46,119	53,526
Do..................................do....	Program B..	28,998	34,157	33,976	39,345	41,775	48,782	52,882	61,429
Stone3/.............................do....	Program A..	13,150	17,702	14,114	18,865	16,054	22,080	20,244	26,765
Do..................................do....	Program B..	13,150	17,702	15,272	20,416	18,710	24,847	23,247	30,768
Sulfur................thousand long tons..	Program A..	3,090	117,988	6,245	206,041	10,196	336,620	15,832	457,480
Do..................................do....	Program B..	3,090	117,988	8,503	283,497	16,296	537,670	23,952	700,376
Summary, nonmetallic minerals...............	Program A..		309,017		458,179		720,833		1,018,546
Do..	Program B..		309,017		530,286		1,006,038		1,501,935
Total, all minerals.........................	Program A..		4,603,557		5,705,669		7,605,044		9,544,724
Do..	Program B..		4,603,557		7,450,818		12,148,842		16,976,534

NA Not available. W Withheld to avoid disclosing company confidential information.
1/ Recoverable content of ores.
2/ Includes tripoli.
3/ Includes shell.

Mineral Industry Water and Land Needs and Projections

Mineral industry in the Lower Mississippi Region diverted an estimated 675 thousand acre-feet of water and depleted 171 thousand acre-feet of this supply to record its 1969 output. Based upon the range of projected increases in mineral production through 2020, diversions should rise to 2,097-3,265 thousand acre-feet, an increase of about 210-380 percent. During the same 1969-2020 interval, depletions should climb to about 619-1,207 thousand acre-feet, an increase of 260-600 percent.

Projections of mineral industry water needs in the region--both diversions and depletions--for the production of individual mineral commodities and mineral groups, as well as industry-wide summaries for the years 1980, 2000, and 2020, are listed in table 6.

Land use by the mineral industry in the Lower Mississippi Region is a small part of the region's 65.5-million-acre total. In 1969, approximately 67 thousand acres was used by mineral industry in the region. Total land needs are projected to increase to 182-253 thousand acres by 2020, an increase of about 170-280 percent. This mineral industry land use represents roughly 0.10 percent of the regional total in 1969, and 0.27-0.37 percent in 2020.

Projections of estimated land needs in the region for the production of fuels, metallic minerals, and nonmetallic minerals, together with summaries for the years 1980, 2000, and 2020, are listed in table 7.

Table 6

Commodity, unit of production	Pro
Fuels:	
Natural gas.....million cubic feet..	Prog
Do.....do....	Prog
Natural gas liquids.....thousand barrels..	Prog
Do.....do....	Prog
Petroleum:	
Production.....do....	Prog
Do.....do....	Prog
Drilling.....thousand feet..	Prog
Do.....do....	Prog
Secondary recovery2/...thousand barrels..	Prog
Do.....do....	Prog
Summary, fuels.....	Prog
Do.....	Prog
Metallic minerals:	
Copper3/.....short tons..	Prog
Do.....do....	Prog
Iron ore (usable).....thousand long tons..	Prog
Do.....do....	Prog
Lead3/.....thousand short tons..	Prog
Do.....do....	Prog
Silver3/.....thousand troy ounces..	Prog
Do.....do....	Prog
Vanadium.....short tons..	Prog
Do.....do....	Prog
Zinc3/.....do....	Prog
Do.....do....	Prog
Summary, metallic minerals.....	Prog
Do.....	Prog
Nonmetallic minerals:	
Abrasives5/.....short tons..	Prog
Do.....do....	Prog
Barite.....do....	Prog
Do.....do....	Prog
Bromine.....thousand pounds..	Prog
Do.....do....	Prog
Cement:	
Masonry.....280-pound barrels..	Prog
Do.....do....	Prog
Portland....thousand 376-pound barrels..	Prog
Do.....do....	Prog
Clays.....short tons..	Prog
Do.....do....	Prog
Gem stones.....pounds..	Prog
Do.....do....	Prog
Gypsum, crude.....short tons..	Prog
Do.....do....	Prog
Lime.....do....	Prog
Do.....do....	Prog
Salt.....thousand short tons..	Prog
Do.....do....	Prog
Sand and gravel.....do....	Prog
Do.....do....	Prog
Stone6/.....do....	Prog
Do.....do....	Prog
Sulfur, Frasch.....thousand long tons..	Prog
Do.....do....	Prog
Summary, nonmetallic minerals.....	Prog
Do.....	Prog
Total, all minerals.....	Prog
Do.....	Prog

NA Not available. W Withheld to avoid disclosi
1/ No significant water use.
2/ Assume 10 percent of production is by seconda
3/ Recoverable content of ores.
4/ Combined with water use for lead mining.
5/ Includes tripoli.
6/ Includes shell.

Table 6 - Lower Mississippi Region, Projections of Mineral Production and Water Needs, 1969, 1980, 2000, and 2020

Commodity, unit of production	Projection	1969			1980			2000			2020
		Production	Water needs, acre-feet		Production	Water needs, acre-feet		Production	Water needs, acre-feet		Production
			Diversion	Depletion		Diversion	Depletion		Diversion	Depletion	
Fuels:											
Natural gas.....million cubic feet..	Program-A..	6,937,000	(1)	(1)	8,579,000	(1)	(1)	11,561,000	(1)	(1)	14,492,000
Do.....do....	Program-B..	6,937,000	(1)	(1)	9,672,000	(1)	(1)	14,365,000	(1)	(1)	18,772,000
Natural gas liquids.....thousand barrels..	Program-A..	119,299	446,999	27,674	168,242	630,274	38,031	246,686	924,197	57,240	326,000
Do.....do....	Program-B..	119,299	446,999	27,674	197,853	741,280	45,809	325,144	1,218,827	74,972	449,000
Petroleum:											
Production.....do....	Program-A..	855,934	(1)	(1)	1,017,239	(1)	(1)	1,298,535	(1)	(1)	1,589,000
Do.....do....	Program-B..	855,934	(1)	(1)	1,455,981	(1)	(1)	2,428,154	(1)	(1)	3,453,000
Drilling.....thousand feet..	Program-A..	41,144	10,614	10,614	49,200	12,695	12,695	62,887	16,229	16,229	76,000
Do.....do....	Program-B..	41,144	10,614	10,614	61,801	15,929	15,929	95,324	24,606	24,606	129,000
Secondary recovery2/...thousand barrels..	Program-A..	342,374	117,918	103,630	508,620	175,801	154,006	805,989	310,916	271,505	1,383,000
Do.....do....	Program-B..	342,374	117,918	103,630	727,990	245,590	221,497	1,675,312	558,977	510,476	5,004,000
Summary, fuels.....	Program-A..	-	575,531	141,918	-	818,770	205,732	-	1,251,342	344,774	
Do.....	Program-B..	-	575,531	141,918	-	1,002,799	285,325	-	1,794,410	610,054	
Metallic minerals:											
Copper3/.....short tons..	Program-A..	W	(4)	(4)	10,500	(4)	(4)	10,500	(4)	(4)	10,000
Do.....do....	Program-B..	W	(4)	(4)	11,500	(4)	(4)	15,170	(4)	(4)	13,000
Iron ore (usable).....thousand long tons..	Program-A..	W	2,319	142	1,356	2,083	185	1,356	2,980	185	1,000
Do.....do....	Program-B..	W	2,319	142	1,584	3,485	214	1,584	3,480	213	1,000
Lead3/.....thousand short tons..	Program-A..	104	542	36	199	1,037	70	200	1,040	70	
Do.....do....	Program-B..	104	542	36	218	1,130	76	250	1,300	87	
Silver3/.....thousand troy ounces..	Program-A..	502	(4)	(4)	960	(4)	(4)	960	(4)	(4)	
Do.....do....	Program-B..	502	(4)	(4)	1,052	(4)	(4)	1,200	(4)	(4)	1,000
Vanadium.....short tons..	Program-A..	W	1,100	549	1,000	1,306	549	1,000	1,306	549	1,000
Do.....do....	Program-B..	W	1,100	549	1,500	1,959	825	2,000	2,612	1,097	3,000
Zinc3/.....do....	Program-A..	15,362	(4)	(4)	29,388	(4)	(4)	30,000	(4)	(4)	30,000
Do.....do....	Program-B..	15,362	(4)	(4)	32,200	(4)	(4)	57,000	(4)	(4)	37,000
Summary, metallic minerals.....	Program-A..	-	3,961	727	-	5,326	802	-	5,326	802	
Do.....	Program-B..	-	3,961	727	-	6,580	1,113	-	7,392	1,397	
Nonmetallic minerals:											
Abrasives5/.....short tons..	Program-A..	W	27	1	7,500	27	1	7,000	25	1	6,000
Do.....do....	Program-B..	W	27	1	8,000	29	1	8,000	29	1	8,000
Barite.....do....	Program-A..	W	3,523	300	213,800	3,946	306	220,200	3,697	316	227,000
Do.....do....	Program-B..	W	3,523	300	294,600	4,046	422	434,700	7,299	625	575,000
Bromine.....thousand pounds..	Program-A..	W	466	466	90,183	581	581	122,362	789	789	154,000
Do.....do....	Program-B..	W	466	466	107,060	689	689	170,804	1,100	1,100	233,000
Cement:											
Masonry.....280-pound barrels..	Program-A..	W	101	44	277,180	162	70	525,020	189	82	396,000
Do.....do....	Program-B..	W	101	44	295,060	172	75	364,801	212	91	453,000
Portland....thousand 376-pound barrels..	Program-A..	W	3,860	1,656	8,087	4,714	2,022	9,644	5,622	2,411	11,000
Do.....do....	Program-B..	W	3,860	1,656	8,598	5,013	2,150	10,725	6,255	2,681	13,000
Clays.....short tons..	Program-A..	2,147,423	963	114	2,827,850	1,265	147	4,074,681	1,822	215	5,682,000
Do.....do....	Program-B..	2,147,423	963	114	3,060,961	1,373	160	4,647,487	2,077	242	6,022,000
Gem stones.....pounds..	Program-A..	NA	(1)	(1)	NA	(1)	(1)	NA	(1)	(1)	
Do.....do....	Program-B..	NA	(1)	(1)	NA	(1)	(1)	NA	(1)	(1)	
Gypsum, crude.....short tons..	Program-A..	W	27	17	185,370	43	27	217,017	65	41	264,000
Do.....do....	Program-B..	W	27	17	197,255	45	28	240,683	73	47	305,000
Lime.....do....	Program-A..	W	37	37	909,267	42	42	1,097,507	49	49	1,357,000
Do.....do....	Program-B..	W	37	37	977,020	45	45	1,239,359	56	56	1,555,000
Salt.....thousand short tons..	Program-A..	W	33,030	9,155	19,948	52,984	14,684	45,508	119,361	32,034	69,000
Do.....do....	Program-B..	W	33,030	9,155	21,902	58,172	16,120	55,828	142,971	39,639	89,000
Sand and gravel.....do....	Program-A..	28,098	6,338	5,548	31,051	6,780	5,798	37,231	8,136	4,360	46,000
Do.....do....	Program-B..	28,098	6,338	5,548	33,576	7,335	4,107	41,775	9,131	5,113	52,000
Stone6/.....do....	Program-A..	13,159	2,797	1,078	14,114	3,004	1,177	16,634	3,550	1,407	20,000
Do.....do....	Program-B..	13,159	2,797	1,078	18,272	5,257	1,267	18,716	5,985	1,589	23,000
Sulfur, Frasch.....thousand long tons..	Program-A..	W	41,164	11,504	6,243	68,945	18,100	10,196	112,589	29,557	13,000
Do.....do....	Program-B..	W	41,164	11,504	8,503	94,896	24,912	16,296	179,952	47,241	23,000
Summary, nonmetallic minerals.....	Program-A..	-	95,333	28,010	-	142,502	40,955	-	252,094	71,460	
Do.....	Program-B..	-	95,333	28,010	-	175,072	49,976	-	353,138	98,423	
Total, all minerals.....	Program-A..	-	674,825	170,655	-	966,598	247,489	-	1,508,762	417,036	
Do.....	Program-B..	-	674,825	170,655	-	1,184,451	334,414	-	2,154,940	709,874	

NA Not available. W Withheld to avoid disclosing company confidential information.
1/ No significant water use.
2/ Assume 40 percent of production is by secondary recovery in 1969, 50 percent in 1980, 69 percent in 2000, and 87 percent in 2020.
3/ Recoverable content of ores.
4/ Combined with water use for lead mining.
5/ Includes tripoli.
6/ Includes shell.

Table 6 - Lower Mississippi Region, Projections of Mineral Production and Water Needs, 1960, 1980, 2000, and 2020

duction	Projection	1960			1980			2000			2020		
		Production	Water needs, acre-feet		Production	Water needs, acre-feet		Production	Water needs, acre-feet		Production	Water needs, acre-feet	
			Diversion	Depletion		Diversion	Depletion		Diversion	Depletion		Diversion	Depletion
on cubic feet..	Program-A..	6,937,000	(1)	(1)	8,579,000	(1)	(1)	11,561,000	(1)	(1)	14,492,000	(1)	(1)
.....do....	Program-B..	6,937,000	(1)	(1)	9,672,000	(1)	(1)	14,365,000	(1)	(1)	18,772,000	(1)	(1)
ousand barrels..	Program-A..	119,299	446,999	27,674	168,242	630,274	38,031	240,686	924,197	57,230	326,836	1,225,781	75,747
.....do....	Program-B..	119,299	446,999	27,674	197,853	741,280	45,809	325,144	1,210,827	74,972	448,530	1,684,310	104,265
.....do....	Program-A..	855,934	(1)	(1)	1,017,259	(1)	(1)	1,298,535	(1)	(1)	1,589,763	(1)	(1)
.....do....	Program-B..	855,934	(1)	(1)	1,455,981	(1)	(1)	2,428,134	(1)	(1)	3,455,826	(1)	(1)
thousand feet..	Program-A..	41,144	10,614	10,614	40,200	12,695	12,695	62,887	16,229	16,229	70,576	19,718	19,718
.....do....	Program-B..	41,144	10,614	10,614	61,801	15,929	15,929	95,524	24,606	24,606	128,831	35,503	35,503
ousand barrels..	Program-A..	342,374	117,918	103,630	508,620	175,801	154,006	895,989	310,916	271,805	1,383,094	480,382	419,256
.....do....	Program-B..	342,374	117,918	103,630	727,990	245,590	221,497	1,675,412	558,977	510,176	5,084,038	996,125	916,222
.....	Program-A..	-	575,531	141,918	-	818,770	205,732	-	1,251,342	341,774	-	1,723,811	511,694
.....	Program-B..	-	575,531	141,918	-	1,302,799	285,525	-	1,794,410	610,084	-	2,715,940	1,054,812
...short tons..	Program-A..	W	(4)	(4)	10,500	(4)	(4)	10,500	(4)	(4)	10,500	(4)	(4)
.....do....	Program-B..	W	(4)	(4)	11,500	(4)	(4)	15,170	(4)	(4)	15,170	(4)	(4)
sand long tons..	Program-A..	W	2,319	142	1,556	2,085	183	1,556	2,980	185	1,356	2,980	185
.....do....	Program-B..	W	2,319	142	1,584	3,185	214	1,584	3,380	213	1,584	3,480	213
and short tons..	Program-A..	104	542	56	199	1,037	70	200	1,040	70	200	1,040	70
.....do....	Program-B..	104	542	56	218	1,136	76	250	1,300	87	250	1,300	87
nd troy ounces..	Program-A..	502	(4)	(4)	960	(4)	(4)	960	(4)	(4)	1,200	(4)	(4)
.....do....	Program-B..	502	(4)	(4)	1,052	(4)	(4)	1,200	(4)	(4)	1,200	(4)	(4)
...short tons..	Program-A..	W	1,100	549	1,000	1,306	549	1,000	1,306	549	1,000	1,306	549
.....do....	Program-B..	W	1,100	549	1,500	1,959	823	2,000	2,612	1,097	5,000	5,918	1,646
.....do....	Program-A..	15,362	(4)	(4)	29,388	(4)	(4)	50,000	(4)	(4)	50,000	(4)	(4)
.....do....	Program-B..	15,362	(4)	(4)	32,200	(4)	(4)	57,000	(4)	(4)	57,000	(4)	(4)
.....	Program-A..	-	3,961	727	-	5,326	802	-	5,326	802	-	5,326	802
.....	Program-B..	-	3,961	727	-	6,580	1,113	-	7,392	1,397	-	8,698	1,946
...short tons..	Program-A..	W	27	1	7,500	27	1	7,000	25	1	6,500	23	1
.....do....	Program-B..	W	27	1	8,000	29	1	8,000	29	1	8,000	29	1
.....do....	Program-A..	W	3,523	300	215,800	3,946	306	220,200	3,697	316	227,800	3,825	326
.....do....	Program-B..	W	3,523	300	294,600	4,046	422	434,700	7,209	625	575,300	9,663	825
ousand pounds..	Program-A..	W	466	466	90,185	581	581	122,562	780	780	154,585	994	994
.....do....	Program-B..	W	466	466	107,060	689	689	170,804	1,100	1,100	235,068	1,507	1,507
pound barrels..	Program-A..	W	101	44	277,180	162	70	328,020	188	82	386,575	232	99
.....do....	Program-B..	W	101	44	295,060	172	75	364,801	212	91	485,083	264	114
pound barrels..	Program-A..	W	3,860	1,656	8,087	4,714	2,022	9,644	5,622	2,411	11,010	6,942	2,977
.....do....	Program-B..	W	3,860	1,656	8,598	5,013	2,150	10,725	6,253	2,681	15,558	7,893	3,384
...short tons..	Program-A..	2,147,423	963	114	2,827,850	1,265	147	4,074,681	1,822	213	5,682,716	2,538	296
.....do....	Program-B..	2,147,423	963	114	3,060,961	1,373	160	4,647,487	2,077	242	6,622,010	2,957	346
.....pounds..	Program-A..	NA	(1)	(1)	NA	(1)	(1)	NA	(1)	(1)	NA	(1)	(1)
.....do....	Program-B..	NA	(1)	(1)	NA	(1)	(1)	NA	(1)	(1)	NA	(1)	(1)
...short tons..	Program-A..	W	27	17	185,370	43	27	217,017	65	41	264,165	70	50
.....do....	Program-B..	W	27	17	197,255	45	28	240,683	73	47	303,503	92	58
.....do....	Program-A..	W	37	37	909,267	42	42	1,097,507	49	49	1,357,891	61	61
.....do....	Program-B..	W	37	37	977,020	45	45	1,230,559	56	56	1,555,141	69	69
nd short tons..	Program-A..	W	33,030	9,155	19,048	52,984	14,684	43,508	115,561	32,034	69,995	185,906	51,527
.....do....	Program-B..	W	33,030	9,155	21,002	58,172	16,120	53,828	142,971	39,639	89,041	238,801	66,210
.....do....	Program-A..	28,098	6,338	3,348	31,051	6,789	3,798	37,231	8,136	4,560	46,119	10,080	5,645
.....do....	Program-B..	28,098	6,338	3,348	33,576	7,335	4,107	41,775	9,131	5,113	52,882	11,563	6,475
.....do....	Program-A..	13,159	2,797	1,078	14,114	3,001	1,177	16,634	3,550	1,407	20,344	4,333	1,731
.....do....	Program-B..	13,159	2,797	1,078	15,272	3,257	1,267	18,716	3,985	1,589	25,247	4,971	1,983
sand long tons..	Program-A..	W	44,164	11,594	6,243	68,045	18,100	10,196	112,589	29,857	13,852	152,068	40,157
.....do....	Program-B..	W	44,164	11,594	8,593	94,896	24,912	16,296	179,052	47,241	25,952	264,502	69,437
s.....	Program-A..	-	95,333	28,010	-	142,502	40,955	-	252,094	71,360	-	367,981	103,864
.....	Program-B..	-	95,333	28,010	-	175,072	49,970	-	353,158	98,323	-	542,401	150,309
.....	Program-A..	-	674,825	170,655	-	966,598	247,489	-	1,508,762	417,036	-	2,097,118	619,270
.....	Program-B..	-	674,825	170,655	-	1,184,451	334,414	-	2,134,040	709,874	-	3,265,039	1,206,867

eld to avoid disclosing company confidential information.

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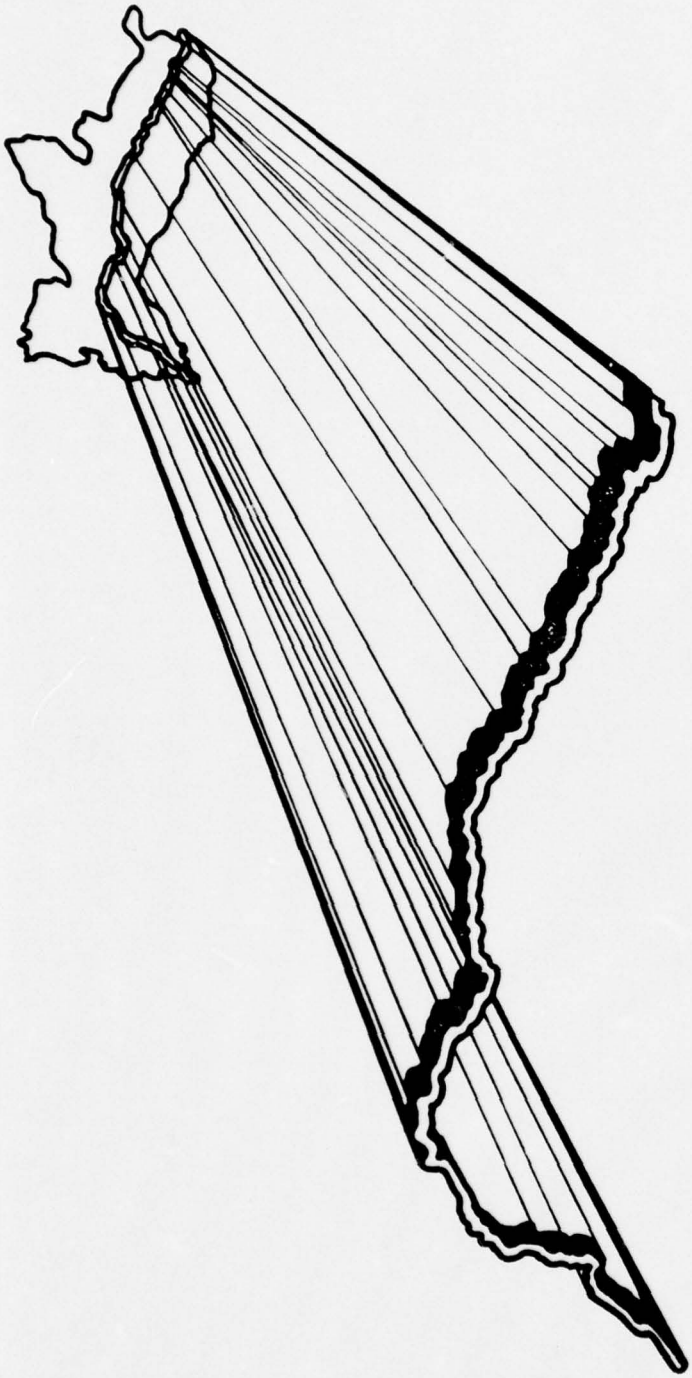
duction is by secondary recovery in 1969, 50 percent in 1980, 69 percent in 2000, and 87 percent in 2020.

res.

for lead mining.

Table 7 - Lower Mississippi Region, Projections of Land Use Needs for Mineral Resources, Acres

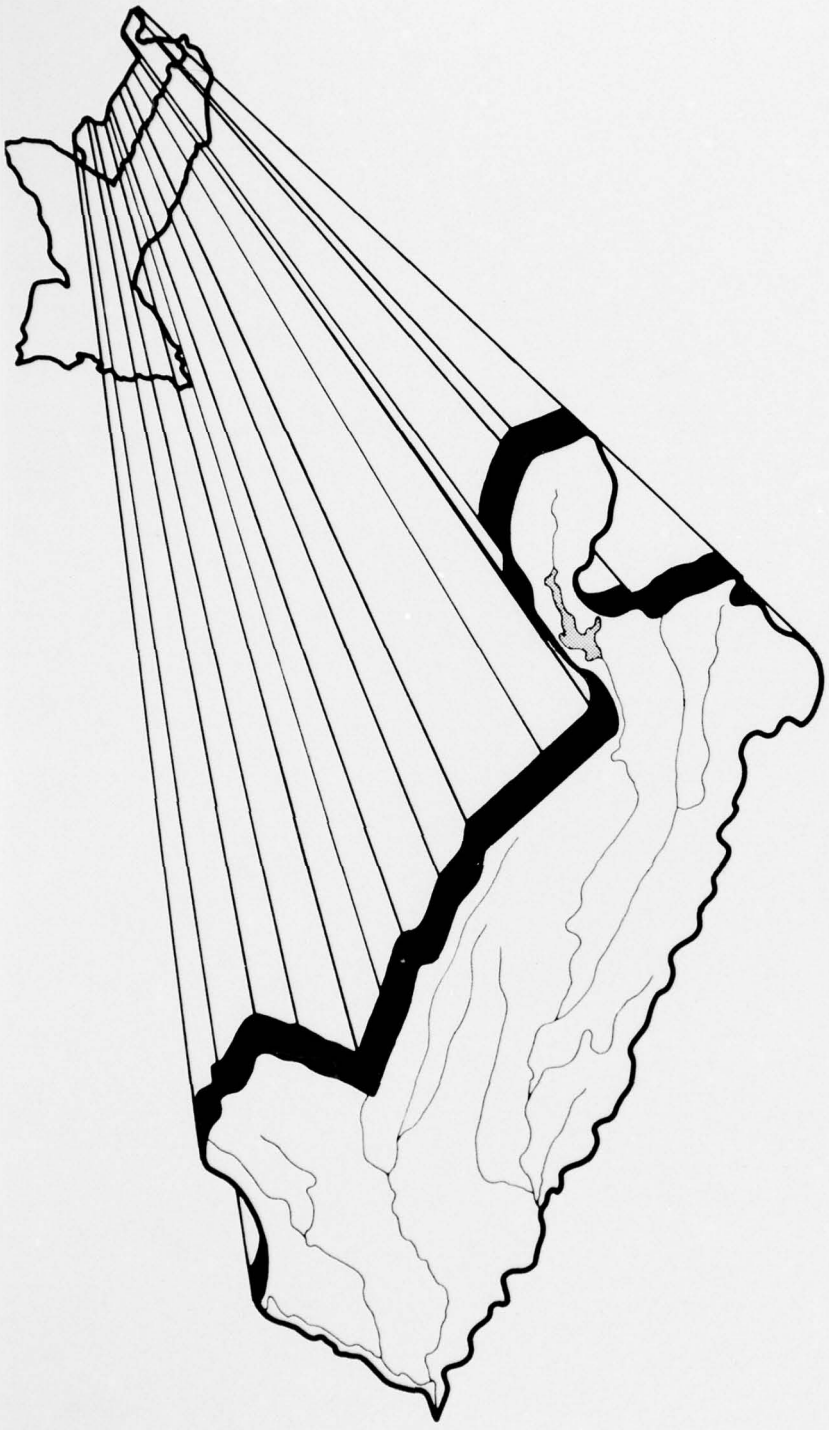
Commodity	Projection	1969	1980	2000	2020
Fuels.....	Program-A.	20,620	24,910	32,765	40,880
Do.....	Program-B.	20,620	31,145	48,675	66,740
Metallic minerals.....	Program-A.	22,600	32,000	52,000	82,000
Do.....	Program-B.	22,600	36,500	68,000	115,000
Nonmetallic minerals..	Program-A.	23,420	29,930	42,435	59,015
Do.....	Program-B.	23,420	32,770	50,040	71,410
Total, all minerals...	Program-A.	66,640	86,840	127,200	181,895
Do.....	Program-B.	66,640	100,415	166,715	253,150



WRPA 1

W R P A 1

Mineral production from WRPA 1, the main stem of the Mississippi River, is credited to the nearest county or parish; therefore, WRPA 1 is not specifically considered herein. Mineral output from WRPA 1, such as sand, gravel, and clay, as well as subsurface oil and gas, is included in other appropriate WRPA mineral data summaries.



WRPA 2

W R P A 2

MINERAL RESOURCE BASE

WRPA 2, the northernmost area in the Lower Mississippi Region, is in southeast Missouri and northeast Arkansas. It is bordered by Missouri and Illinois counties on the north, by counties in Kentucky, Tennessee, and Mississippi on the east, by Arkansas counties on the south, and by counties in Arkansas and Missouri on the west. The 26 counties in the area are as follows:

ARKANSAS
- Arkansas
- Clay
- Craighead
- Cross
- Greene
- Jackson
- Lee
- Lonoke
- Mississippi
- Monroe
- Phillips
- Poinsett
- Prairie
- St. Francis
- White
- Woodruff

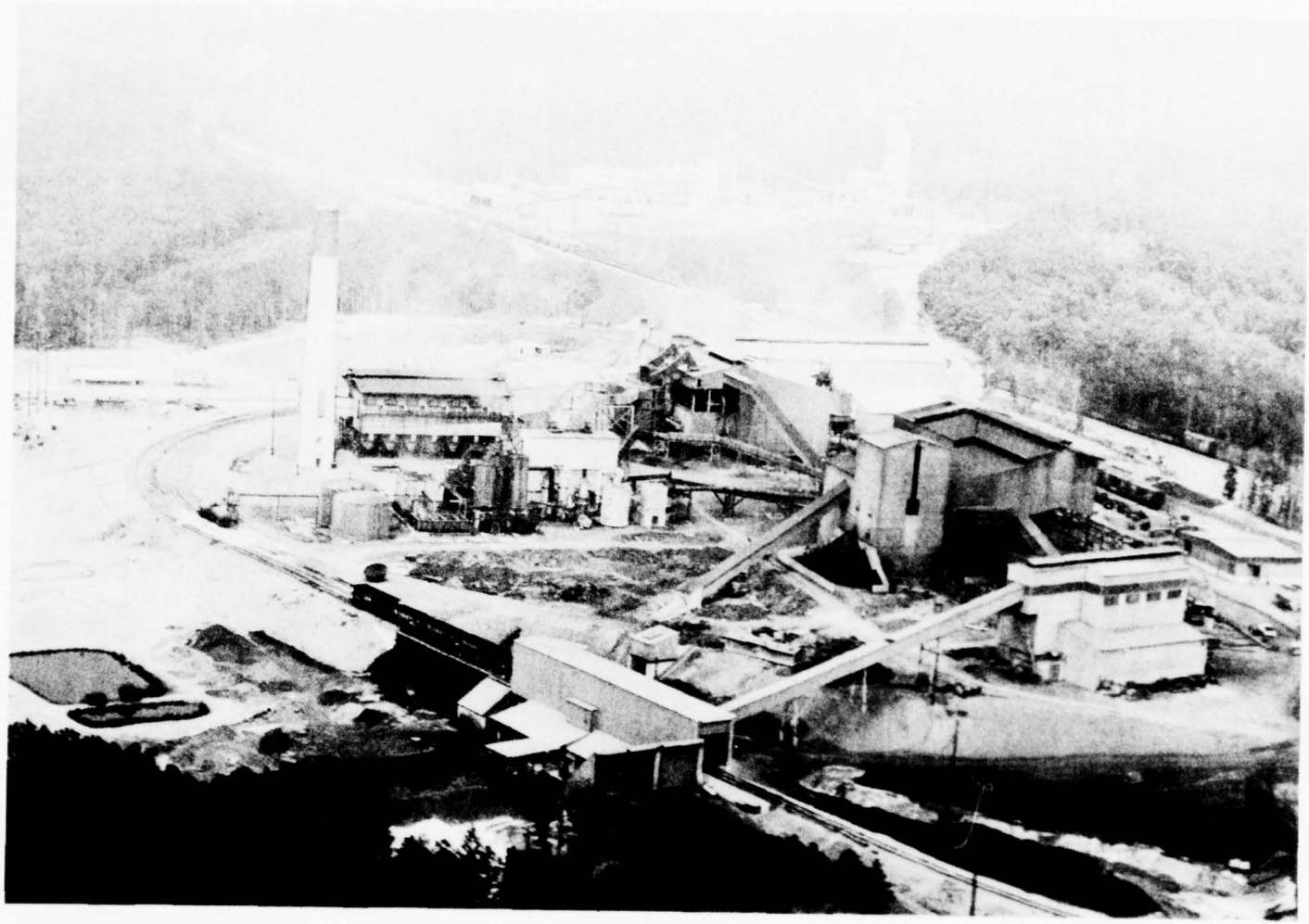
MISSOURI
- Bollinger
- Dunklin
- Iron
- Madison
- Mississippi
- New Madrid
- Pemiscot
- Scott
- Stoddard
- Wayne

Nonmetallic minerals are produced in almost all counties in the area in any given year. The base metals, lead-zinc-copper and byproduct silver, are produced in Iron County, Mo. Iron ore also is produced in Iron County. Lignite deposits exist in the Arkansas part of the area, but their near-term development is not foreseen. The sedimentary rock column increases in thickness from north to south, building to 20,000+ feet of strata in the southernmost part of the area. Although oil and gas are not produced nor is such output foreseen at present, the long-range potential for production remains worthy of note.

Metallic Minerals

Lead

Lead ores are found in the southeast Missouri lead district in the Viburnum trend (new lead belt), a north-south trend of mineralization outside of the hydrologic region in western Iron County. The Viburnum trend is about 50 miles west of the old lead belt, site of lead discoveries by French explorers at the turn of the 18th century. Lead resources in southeast Missouri probably are sufficient to satisfy the most optimistic projections of growth in demand. Limited to the counties within WRPA 2, wherein the area covered by the Viburnum trend is not as extensive as the area of the old lead belt, the resource base is assumed to be somewhat constrained. The lead resource base, however, is taken to



Aerial view of Magmont mine and mill (background) and lead smelter of Missouri Lead Tollers (foreground), Iron County, Mo.

to be sufficient to support a substantial increase in output through 1980, and then capable of sustaining a high plateau of production through 2020.

Zinc and Copper

Zinc ores have been produced in southeast Missouri, but only in negligible tonnage. Zinc as well as copper, however, are recovered in substantial quantities as byproducts from lead ores. Silver also is recovered in notable amounts, and in the past relatively minor quantities of cobalt and nickel have been recovered as byproducts. Lead and the zinc and copper byproducts remain the principal metals of economic interest. In approximate terms, the lead-zinc-copper ratio in lead ores is 20:3:1.

Iron Ore

Extensive deposits of limonite (brown iron ore) and filled-sink hematite deposits occur in southern Missouri and extend into northern Arkansas. The low phosphorous content of the limonite ores made them attractive for blending with other ores in the recent past. Technological trends in iron smelting now favor the hematite and magnetite ores of Precambrian age found in southeast Missouri. Iron ore of current interest in WRPA 2 is found in the region of the Ozark uplift which is centered in Iron County. Iron resources in southern Missouri are huge, but in counties within WRPA 2, the resource base is constrained. Iron resources are viewed as sufficient to support increased output through 1980, and a plateau of steady production through 2020.

Nonmetallic Minerals

Clays, Sand, Gravel, and Stone

Sand and gravel deposits exist throughout most of WRPA 2. Stone outcrops are found in the western part of the area, well removed from the Mississippi River. Clays are fairly common in the area. The resource base of all these construction raw materials is adequate to satisfy projections of output through 2020.

PRESENT MINERAL PRODUCTION

Mineral production in WRPA 2 historically has been dominated by lead and associated metals output in southeastern Missouri. It is expected that this base-metal dominance will continue through 2020.

In 1969, total value of mineral production in the area was $48.2 million. Metallic minerals comprised about 85 percent of this total. Nonmetallic minerals made up the remainder of the total value. Almost all counties in the area record some nonmetallic minerals output in any given year. There was no 1969 production of mineral fuels in WRPA 2.

Table 8 lists the mineral production in WRPA 2 by commodity, unit of production, quantity, and value (in current dollars) for the years 1956, 1963, and 1969, and a summary of quantity and value for the years 1956-69, inclusive.

PROJECTIONS OF MINERAL PRODUCTION AND RELATED WATER AND LAND NEEDS

Projections of Mineral Production

Metallic minerals output in WRPA 2 is expected to increase appreciably through 1980 and then remain at a high level through 2020 for Program A. Projected value of metallic minerals increases from $48.8 million in 1969 to $87.2 million in 1980, a 79-percent increase. Nonmetallic minerals output is expected to increase throughout the period. Value of production is projected to increase from $8.45 million in 1969 to $11.34 million in 2020, a rise of 34 percent.

Projections for individual minerals and summaries for the years 1980, 2000, and 2020 are listed in table 9. Data are projected in the specific unit of production for each of the minerals, and all values are in terms of 1967 dollars.

Projections of Water and Land Needs

Mineral industry in WRPA 2 diverted an estimated 4,450 acre-feet of water and depleted 659 acre-feet of this supply to record its 1969 output. Based upon projected increases in mineral production through 2020, diversions should rise to 6,154-7,230 acre-feet, an increase of 38-62 percent. During the same 1969-2020 period, depletions should climb to about 900-1,042 acre-feet, an increase of 37-58 percent.

Projections of water needs--both diversions and depletions--for the production of individual mineral commodities and summary totals for the years 1980, 2000, and 2020 are listed in table 10.

Land use in WRPA 2 by mineral industry is a relatively small part of total acreage in the area. In 1969, approximately 25,600 acres was in use. Total land needs are expected to increase to about 86.5-118.2 thousand acres by 2020, a 240-360 percent escalation.

Projections of estimated land needs for the production of metallic and nonmetallic minerals, and summaries for the years 1980, 2000, and 2020, are listed in table 11.

Table 8 - WRPA 2, Mineral Production, 1956, 1963, 1969, and Total 1956-1969
(Values in thousand current dollars)

Commodity, unit of production	1956		1963		1969		Total 1956 - 1969	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Clays.....short tons..	7,970	$8	W	W	194,895	$342	947,892	$1,193
Copper1/.....do....	1,065	905	177	$109	W	5,205	14,088	11,250
Iron ore (usable).....thousand long tons..	3	17	3	17	W	W	1,277	17,447
Lead1/.....thousand short tons..	14	4,260	16	3,529	104	30,902	311	86,787
Natural gas.....million cubic feet..	0	0	0	0	0	0	6	1
Sand and gravel.....thousand short tons..	2,320	1,657	2,447	2,310	3,401	3,515	41,459	40,530
Silver1/.....thousand troy ounces..	3	3	42	54	502	W	871	1,382
Stone.....thousand short tons..	483	884	1,667	2,056	2,985	3,702	20,784	30,151
Zinc1/.....short tons..	0	0	0	0	15,362	4,486	20,776	6,017
Total.....		7,734		W		48,152		194,738

W Withheld to avoid disclosing company confidential information.
1/ Recoverable content of ores.

Table 9 - WRPA 2, Mineral Production and Value, 1969, and Projections for 1980, 2000, and 2020
(Thousand 1967 dollars adjusted by Bureau of Mines price indexes for selected minerals)

Commodity, unit of production	Projection	1969		1980		2000		2020	
		Production	Value	Production	Value	Production	Value	Production	Value
Metallic minerals:									
Copper[1/]....short tons..	Program-A.	W	W	10,500	$8,138	10,500	$8,138	10,500	$8,138
Do....do....	Program-B.	W	W	11,500	8,912	13,170	10,200	13,170	10,200
Iron ore (usable)....thousand long tons..	Program-A.	W	W	1,356	12,706	1,356	12,706	1,356	12,706
Do....do....	Program-B.	W	W	1,584	14,842	1,584	14,842	1,584	14,842
Lead[1/]....thousand short tons..	Program-A.	104	$29,328	199	56,118	200	56,400	200	56,400
Do....do....	Program-B.	104	29,328	218	61,476	250	70,500	250	70,500
Silver[1/]....thousand troy ounces..	Program-A.	502	1,074	960	2,054	960	2,054	960	2,054
Do....do....	Program-B.	502	1,074	1,052	2,251	1,200	2,600	1,200	2,600
Zinc[1/]....short tons..	Program-A.	15,362	4,286	29,388	8,199	30,000	8,370	30,000	8,370
Do....do....	Program-B.	15,362	4,286	32,200	8,984	37,000	10,320	37,000	10,320
Summary, metallic minerals....	Program-A.	-	48,807	-	87,215	-	87,668	-	87,668
Do....	Program-B.	-	48,807	-	96,465	-	108,462	-	108,462
Nonmetallic minerals:									
Clays....short tons..	Program-A.	194,895	232	199,767	238	223,155	266	261,549	311
Do....do....	Program-B.	194,895	232	221,791	264	246,152	293	300,333	357
Sand and gravel....thousand short tons..	Program-A.	3,401	3,741	3,486	3,835	3,894	4,285	4,564	5,020
Do....do....	Program-B.	3,401	3,741	3,870	4,257	4,295	4,724	5,241	5,765
Stone....do....	Program-A.	2,985	4,477	3,060	4,590	3,418	5,127	4,006	6,009
Do....do....	Program-B.	2,985	4,477	3,397	5,095	3,770	5,655	4,600	6,900
Summary, nonmetallic minerals....	Program-A.	-	8,450	-	8,663	-	9,676	-	11,340
Do....	Program-B.	-	8,450	-	9,616	-	10,672	-	13,022
Total, all minerals....	Program-A.	-	57,257	-	95,878	-	97,344	-	99,008
Do....	Program-B.	-	57,257	-	106,081	-	119,134	-	121,482

W Withheld to avoid disclosing company confidential information.
1/ Recoverable content of ores.

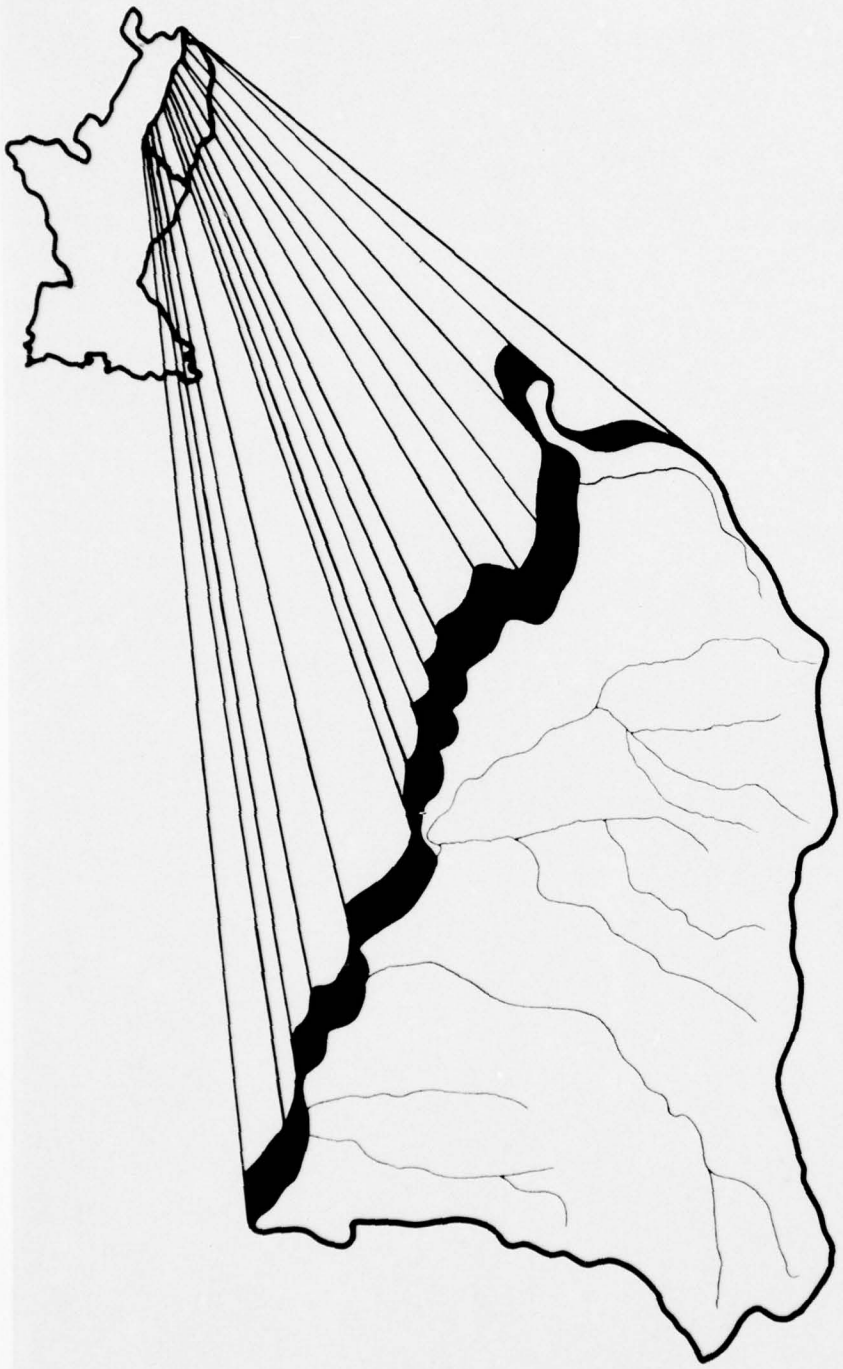
Table 10 - WRPA 2, Projections of Mineral Production and Water Needs, 1960, 1980, 2000, and 2020

Commodity, unit of production	Projection	1960			1980			2000			2020		
		Production	Water needs, acre-feet		Production	Water needs, acre-feet		Production	Water needs, acre-feet		Production	Water needs, acre-feet	
			Diversion	Depletion		Diversion	Depletion		Diversion	Depletion		Diversion	Depletion
Metallic minerals:													
Copper(1)...short tons..	Program-A.	W	(2)	(2)	10,500	(2)	(2)	10,500	(2)	(2)	10,500	(2)	(2)
do....	Program-B.	W	(2)	(2)	11,500	(2)	(2)	13,170	(2)	(2)	13,170	(2)	(2)
Iron ore (usable)...thousand long tons..	Program-A.	W	2,310	142	1,350	2,083	185	1,350	2,980	143	1,356	2,980	185
do....	Program-B.	W	2,310	142	1,384	5,485	214	1,384	5,480	213	1,584	5,480	215
Lead(1)...thousand short tons..	Program-A.	104	542	36	199	1,017	70	200	1,140	79	200	1,140	79
do....	Program-B.	104	542	36	218	1,136	76	250	1,300	87	250	1,300	87
Silver(1)...thousand troy ounces..	Program-A.	502	(2)	(2)	960	(2)	(2)	960	(2)	(2)	1,200	(2)	(2)
do....	Program-B.	502	(2)	(2)	1,032	(2)	(2)	1,200	(2)	(2)	30,000	(2)	(2)
Zinc(1)...short tons..	Program-A.	15,362	(2)	(2)	29,588	(2)	(2)	30,000	(2)	(2)	37,000	(2)	(2)
do....	Program-B.	15,362	(2)	(2)	32,200	(2)	(2)	37,000					
									4,020	253	-	4,020	253
Summary, metallic minerals....	Program-A.		2,861	178	-	4,020	253	-	4,780	300	-	4,780	300
do....	Program-B.		2,861	178	-	4,621	290	-					
Nonmetallic minerals:													
Clays...short tons..	Program-A.	134,805	86	10	194,767	88	10	223,155	100	15	261,549	116	14
do....	Program-B.	134,805	86	10	221,791	98	12	246,152	851	477	4,564	998	559
Sand and gravel...thousand short tons..	Program-A.	5,401	743	416	5,486	762	427	5,894	970	526	5,241	1,146	641
do....	Program-B.	5,401	743	410	5,870	846	474	4,295	670	63	4,006	1,020	74
Stone...do....	Program-A.	2,547	760	55	5,066	779	56	3,418	900	69	4,600	1,171	85
do....	Program-B.	2,085	760	55	5,397	865	63	3,770					
									1,620	592	-	2,134	847
Summary, nonmetallic minerals....	Program-A.	-	1,589	481	-	1,629	493	-	2,008	608	-	2,430	742
do....	Program-B.	-	1,589	481	-	1,809	549	-					
									5,840	805	-	6,154	900
Total, all minerals....	Program-A.	-	4,450	659	-	5,649	746	-	6,788	908	-	7,210	1,042
do....	Program-B.	-	4,450	659	-	6,430	839	-					

W Withheld to avoid disclosing company confidential information.
1/ Recoverable content of ores.
2/ Combined with water use for lead mining.

Table 11 - WRPA 2, Projections of Land Use Needs for Mineral Resources, Acres

Commodity	Projection	1969	1980	2000	2020
Metallic minerals.....	Program-A.	21,600	31,000	51,000	81,000
Do.....	Program-B.	21,600	35,000	66,000	112,000
Nonmetallic minerals....	Program-A.	4,000	4,100	4,600	5,500
Do.....	Program-B.	4,000	4,500	5,100	6,200
Total, all minerals.....	Program-A.	25,600	35,100	55,600	86,500
Do.....	Program-B.	25,600	39,500	71,000	118,200



WRPA 3

W R P A 3

MINERAL RESOURCE BASE

WRPA 3 is located mostly in western Tennessee, but extends into Arkansas, Kentucky, and Mississippi. It is bordered by counties in Kentucky and Missouri on the north, and by counties in Tennessee on the east, Mississippi on the south, and Arkansas and Missouri on the west. The 23 counties in the area are as follows:

ARKANSAS
- Crittenden

KENTUCKY
- Carlisle
- Fulton
- Graves
- Hickman

MISSISSIPPI
- Alcorn
- Tippah

TENNESSEE
- Carroll
- Chester
- Crockett
- Dyer
- Fayette
- Gibson
- Hardeman
- Haywood
- Lake
- Lauderdale
- McNairy
- Madison
- Obion
- Shelby
- Tipton
- Weakley

Nonmetallic minerals are produced in most counties in the area in any given year. The resource base is assumed to be sufficient to support the projections of mineral production through the year 2020. There are no known metallic mineral deposits in the area. Neither oil nor gas is produced nor is such production foreseen. Lignite deposits exist in western Tennessee, but its production is not anticipated.

Nonmetallic Minerals

Clay

Extensive deposits of ball clay, a high-grade ceramic raw material, are found in Weakley County, Tenn., and extend into Graves County, Ky. Ball clay is highly plastic because of its very fine particle size and generally is refractory. Similar in use to china clay, it is blended with feldspar and flint in the manufacture of whitewares. The resource base is believed to be adequate to meet foreseen production through 2020. Other clays, mostly of local importance, are found in scattered deposits in the area.

Sand, Gravel, and Stone

Sand and gravel deposits of variable quality are found throughout most of the area. The resource base is sufficient to meet anticipated output through 2020. Readily accessible stone deposits are limited in the area.

PRESENT MINERAL PRODUCTION

Mineral production in WRPA 3 has been limited to the important ball clay output in the northern part of the area, fairly widespread sand and gravel output, and stone production in the vicinity of Memphis. Ball clay is marketed extensively, whereas sand, gravel, and stone are locally consumed.

In 1969, total value of mineral production in WRPA 3 was in excess of $6 million. Nonmetallic minerals accounted for all output.

Table 12 lists the mineral production in the area by commodity, unit of production, quantity, and value (in current dollars) for the years 1956, 1963, and 1969, and includes a summary of quantity and value for the years 1956-69, inclusive.

PROJECTIONS OF MINERAL PRODUCTION AND RELATED WATER AND LAND NEEDS

Projections of Mineral Production

Production of ball clay in WRPA 3 is expected to increase sharply during the 1969-2020 interval to satisfy national demands. Output of sand, gravel, and stone should expand in step with area growth. Value of nonmetallic mineral output may advance from about $6 million to the $28.8-29.8 million range by 2020 (all in terms of 1967 dollars), which represents an increase of approximately 380 percent in value of production.

Projections of mineral production and value, as well as summaries for the years 1980, 2000, and 2020, are listed in table 13. Data are projected in the specified unit of production for the individual mineral commodities, and all values are in terms of 1967 dollars.

Projections of Water and Land Needs

Mineral industry in WRPA 3 diverted an estimated 810 acre-feet of water and depleted 346 acre-feet of this supply to record its 1969 output. Based upon foreseen increases in mineral output through 2020, diversions are expected to rise to about 2.3-2.5 thousand acre-feet, an increase of about 185-210 percent. During the same 1969-2020 interval, depletions should climb to approximately 788-898 acre-feet, an increase of 130-160 percent.

Projections of water needs--both diversions and depletions--for the production of individual mineral commodities, together with summaries for the years 1980, 2000, and 2020, are listed in table 14.

Table 12 - WRPA 3, Mineral Production, 1956, 1963, 1969, and Total 1956-1969
(Values in thousand current dollars)

Commodity, unit of production	1956		1963		1969		Total 1956 - 1969	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Clays.....short tons..	513,084	$4,960	499,021	$5,128	319,703	$3,711	6,643,721	$68,812
Sand and gravel.....thousand short tons..	2,511	2,206	3,736	3,452	2,631	2,902	41,270	41,476
Stone.....do....	0	0	0	0	W	W	W	W
Total[1/].....		7,165		8,580		W		110,968

W Withheld to avoid disclosing individual company confidential data.
1/ Figures may not add because of rounding.

Table 13 - WRPA 3, Mineral Production and Value, 1969, and Projections for 1980, 2000, and 2020
(Thousand 1967 dollars adjusted by Bureau of Mines price indexes for selected minerals)

Commodity, unit of production	Projection	1969		1980		2000		2020	
		Production	Value	Production	Value	Production	Value	Production	Value
Nonmetallic minerals:									
Clays.....short tons..	Program-A-B	319,703	$3,358	639,400	$6,716	1,332,200	$13,992	2,131,500	$22,387
Sand and gravel.....thousand short tons..	Program-A..	2,631	2,626	2,990	2,984	4,020	4,012	5,420	5,409
Do.....do....	Program-B..	2,631	2,626	3,280	3,273	4,570	4,561	6,300	6,287
Stone.....do....	Program-A..	W	W	421	534	567	718	764	969
Do.....do....	Program-B..	W	W	463	586	645	817	888	1,125
Total, nonmetallic minerals.....	Program-A..	-	W	-	10,234	-	18,722	-	28,765
Do.....	Program-B..	-	W	-	10,575	-	19,370	-	29,799

W Withheld to avoid disclosing company confidential information.

Table 14 - WRPA 5, Projections of Mineral Production and Water Needs, 1960, 1980, 2000, and 2020

Commodity, unit of production	Projection	1960			1980			2000			2020		
		Production	Water needs, acre-feet		Production	Water needs, acre-feet		Production	Water needs, acre-feet		Production	Water needs, acre-feet	
			Diversion	Depletion		Diversion	Depletion		Diversion	Depletion		Diversion	Depletion
Nonmetallic minerals:													
Gravel.....short tons..	Program-A/B	319,793	141	17	650,410	282	33	1,332,200	588	68	2,131,500	941	111
	Program-A..		575	322		717	401		879	492		1,420	1,162
Sand and gravel.....thousand short tons..	Program-A..	2,651	575	322	3,280	717	401	4,370	944	550	6,500	1,377	771
	Program-B..	2,032	575	322	3,280	717	401	4,370	944	550	6,500	1,377	771
(A).....	Program-A..	W	94	7	421	107	8	967	144	12	764	195	14
	Program-B..	W	94	7	469	118	9	645	164	12	888	220	16
Stone.....do.....	Program-A..	W	94	7	469	118	9	645	164	12	888	220	16
	Program-B..												
(A).....			810	346		1,042	417		1,611	571		2,521	788
			810	346		1,117	443		1,751	640		2,544	808
Total, nonmetallic minerals.....	Program-A..												
(A).....	Program-B..												

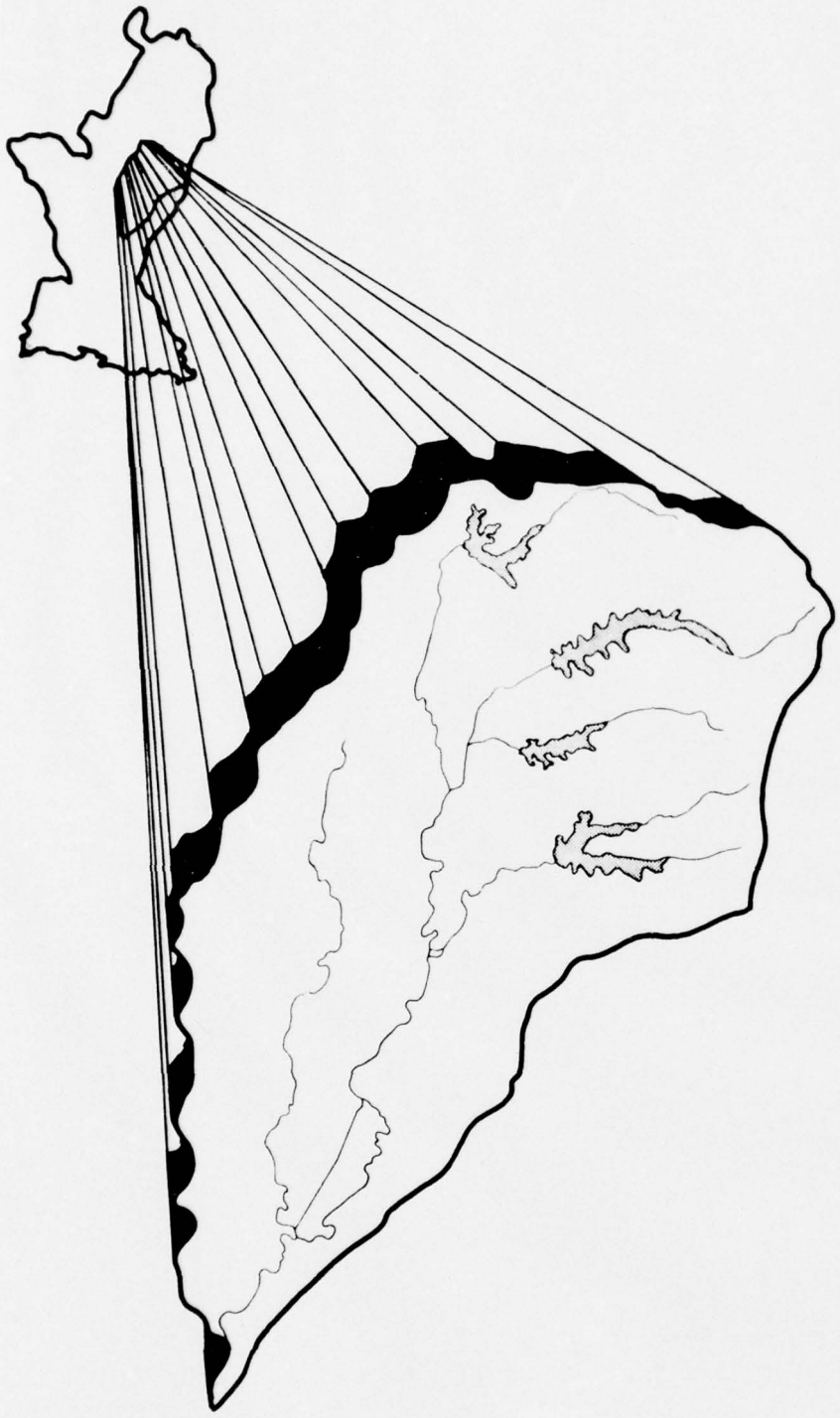
W Withheld to avoid disclosing company confidential information.
1/ Projected on national demand.
2/ Assume 95 percent will be wasted.

Land use by mineral industry in WRPA 3 is a very small fraction of total acreage in the area. In 1969, mineral industry land use amounted to 2.4 thousand acres. By 2020, land needs are expected to swell to about 14.0-14.2 thousand acres, representing about a 480-percent increase.

Projections of estimated land needs for the production of nonmetallic minerals for the years 1980, 2000, and 2020 are listed in table 15.

Table 15 - WRPA 3, Projections of Land Use Needs for Mineral Resources, Acres

Commodity	Projection	1969	1980	2000	2020
Nonmetallic minerals...	Program-A.	2,400	4,400	8,900	14,000
Do.....	Program-B.	2,400	4,450	9,000	14,200
Total, all minerals....	Program-A.	2,400	4,400	8,900	14,000
Do.....	Program-B.	2,400	4,450	9,000	14,200



WRPA 4

W R P A 4

MINERAL RESOURCE BASE

WRPA 4 is in northwestern Mississippi. It is bordered by counties in Arkansas and Louisiana on the west (along the Mississippi River), Tennessee counties on the north, and Mississippi counties on the east and south. The 26 counties in the area are as follows:

Benton	Issaquena	Sunflower
Bolivar	Lafayette	Tallahatchie
Calhoun	Leflore	Tate
Carroll	Marshall	Tunica
Coahoma	Pauola	Union
DeSoto	Pontotoc	Warren
Grenada	Quitman	Washington
Holmes	Sharkey	Yalobusha
Humphrey		Yazoo

Oil and gas are produced in the southern part of the area. Geologic conditions are favorable for oil and gas accumulations northward into the central part of the area. Lignite deposits exist in the southern and eastern parts, and their possible future development should be noted. Nonmetallic minerals are produced in about two-thirds of the 26 counties in the area in any given year. Metallic minerals are not produced in the region, and geologic conditions do not favor their occurrence.

Mineral Fuels

Petroleum and Natural Gas

Most oil and gas produced in Mississippi is recovered from the tier of counties that make up the southern one-third of the State. Production in WRPA-4 has been limited to the area's southernmost counties, which are in the middle-third of the State. However, the Desha basin underlies the west-central part of the area and, containing up to 20,000 feet of sediments, it has a good potential for oil and gas deposits. Unfortunately, the cost of drilling exploration wells increases almost geometrically with depth and, therefore, is a negative factor in exploration programs. (Average depth of all wells drilled in Mississippi in recent years has been in excess of 8,000 feet, compared with a national average of a little less than 5,000 feet.)

Specific reserve data for WRPA 4 are not available, but as of December 31, 1969, Mississippi had proved recoverable reserves of 360 million barrels of crude oil and 1.41 trillion cubic feet of natural gas.

The Lower Mississippi Region had estimated resources of 137 billion barrels of oil and 616 trillion cubic feet of gas.

During the period 1956-69, WRPA 4 produced about 4 percent of the crude oil and 0.2 percent of the natural gas in the region. Assuming a similar share of the total estimated resources, WRPA 4 would have approximately 550 million barrels of oil and 1.0 trillion cubic feet of gas remaining (table 3). Projected total petroleum output through 2020 ranges between 200 and 234 million barrels. Cumulative gas output through 2020 would be a maximum of 14 billion cubic feet. The oil and gas resource base, therefore, seems capable of supporting production projections through 2020.

Nonmetallic Minerals

Clay, Sand, Gravel, and Stone

Clays, sand, and gravel are found throughout much of the area. Stone outcrops are less commonplace. The resource base of these construction minerals generally is adequate to meet foreseen production through 2020.

PRESENT MINERAL PRODUCTION

Oil and gas output in the southern part of WRPA 4 and widespread production of construction minerals define the mineral industry activity in the area. Sand and gravel is produced in more than half the counties in the area in any given year to meet local needs. Clay is produced in several counties, mostly for local consumption, and stone is produced in Warren County. Cement is manufactured in Warren County from locally produced minerals for regionwide markets.

Total value of mineral output in WRPA 4 in 1969 was almost $15 million and about equally divided between fuels and nonmetallic minerals.

Table 16 lists the mineral production in the area by commodity, unit of production, quantity, and value (in current dollars) for the years 1956, 1963, and 1969, plus a summary of quantity and value for the years 1956-69, inclusive.

Table 16 - WRPA 4, Mineral Production, 1956, 1963, 1969, and Total 1956-1969
(Values in thousand current dollars)

Commodity, unit of production	1956		1963		1969		Total 1956 - 1969	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Cement:								
Masonry.....280-pound barrels..	0	0	W	W	W	W	W	W
Portland.....thousand 376-pound barrels..	0	0	W	W	W	W	W	W
Clays.....short tons..	106,698	$378	215,389	$940	303,904	$1,643	2,766,761	$13,022
Natural gas.....million cubic feet.	1/NA	1/NA	10	2	112	20	477	84
Petroleum.....thousand barrels..	NA	11,486	3,267	9,016	2,627	7,663	29,653	126,533
Sand and gravel.....thousand short tons..	2,082	1,997	1,954	2,084	3,451	3,900	34,253	36,054
Stone.....do....	0	0	W	W	W	W	W	W
Total.....		13,861		14,767		14,718		204,085

W Withheld to avoid disclosing company confidential information.
1/ Included with petroleum.

PROJECTIONS OF MINERAL PRODUCTION AND RELATED WATER AND LAND NEEDS

Projections of Mineral Production

Production of oil and gas is expected to increase about 250 percent by 2020 from the modest output in 1969. In all probability, the statistical method used to develop this estimate does not do justice to the oil and gas potential of this area. Value of mineral fuels output should increase from $7.2 million in 1969 to $14.2-17.7 million in 2020 (all in terms of 1967 dollars). Value of nonmetallic mineral production is projected to grow from $7.5 million to $12.3-17.3 million. Total value of mineral production, therefore, is projected to increase from $14.7 million in 1969 to $26.6-34.9 million in 2020, about an 80- to 140-percent increase during the interval.

Projection data for individual minerals and summaries for the years 1980, 2000, and 2020 are listed in table 17. Data are projected in the specified unit of production for each of the mineral commodities, and all values are in terms of 1967 dollars.

Projections of Water and Land Needs

Mineral industry water needs in WRPA 4 were an estimated 1,205 acre-feet of diversions and 598 acre-feet of depletions during 1969. Water needs to support projected mineral output through 2020 would climb to 1.8-2.2 thousand acre-feet of diversions, an increase of about 50-85 percent. Depletions would advance to about 840-990 acre-feet, an increase of 40-65 percent.

Projections of water needs--both diversions and depletions--for the production of individual mineral commodities are listed in table 18, together with summaries for the years 1980, 2000, and 2020.

Land use by mineral industry in WRPA 4 is a small fraction of total acreage in the area. Mineral industry land use amounted to an estimated 3.3 thousand acres in 1969. By 2020, land use is expected to increase to 5.3-7.4 thousand acres, an increase of 60-125 percent.

Projections of estimated land needs for minerals output for the years 1980, 2000, and 2020 are listed in table 19.

Table 17 - WRPA 4, Mineral Production and Value, 1969, and Projections for 1980, 2000, and 2020
(Thousand 1967 dollars adjusted by Bureau of Mines price indexes for selected minerals)

Commodity, unit of production	Projection	1969		1980		2000		2020	
		Production	Value	Production	Value	Production	Value	Production	Value
Fuels:									
Natural gas.....million cubic feet..	Program-A.	112	$19	150	$26	220	$38	289	$49
Do.....do....	Program-B.	112	19	183	31	305	52	426	73
Petroleum.....thousand barrels..	Program-A.	2,627	7,159	3,213	8,755	4,235	11,540	5,204	14,181
Do.....do....	Program-B.	2,627	7,159	3,507	9,557	5,012	13,658	6,452	17,582
Summary, fuels.....	Program-A.	-	7,178	-	8,781	-	11,578	-	14,230
Do.....	Program-B.	-	7,178	-	9,588	-	15,710	-	17,655
Nonmetallic minerals:									
Cement:									
Masonry.....280-pound barrels..	Program-A.	W	W	10,000	30	10,900	33	13,000	39
Do.....do....	Program-B.	W	W	10,800	32	12,400	37	14,700	44
Portland.....thousand 376-pound barrels..	Program-A.	W	W	410	1,414	448	1,546	529	1,825
Do.....do....	Program-B.	W	W	442	1,525	508	1,753	601	2,073
Clays.....short tons..	Program-A.	303,904	2,240	362,400	2,671	517,700	3,815	766,200	5,647
Do.....do....	Program-B.	303,904	2,240	450,400	3,319	828,400	6,105	1,309,900	9,654
Sand and gravel.....thousand short tons..	Program-A.	3,451	3,755	3,350	3,645	3,694	4,019	4,363	4,747
Do.....do....	Program-B.	3,451	3,755	3,651	3,972	4,189	4,558	4,958	5,394
Stone.....do....	Program-A.	W	W	60	70	66	77	78	91
Do.....do....	Program-B.	W	W	65	76	74	87	88	103
Summary, nonmetallic minerals.....	Program-A.	-	7,541	-	7,830	-	9,490	-	12,349
Do.....	Program-B.	-	7,541	-	8,924	-	12,540	-	17,268
Total, all minerals.....	Program-A.	-	14,719	-	16,611	-	21,068	-	26,579
Do.....	Program-B.	-	14,719	-	18,512	-	26,250	-	34,923

W Withheld to avoid disclosing company confidential information.

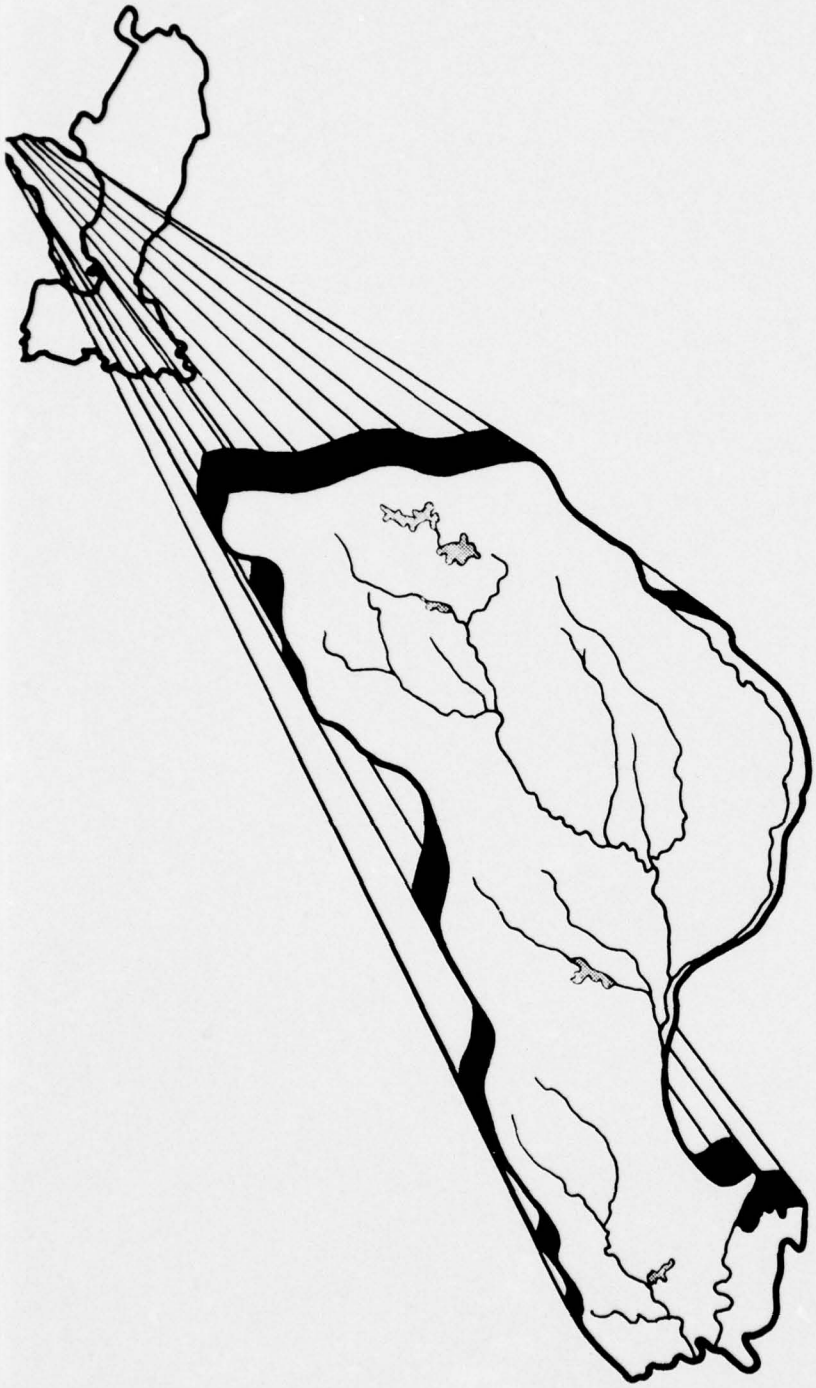
Table 18 - WRPA 4, Projections of Mineral Production and Water Needs, 1969, 1980, 2000, and 2020

Commodity, unit of production	Projection	1969			1980			2000			2020		
		Production	Water needs, acre-feet		Production	Water needs, acre-feet		Production	Water needs, acre-feet		Production	Water needs, acre-feet	
			Diversion	Depletion		Diversion	Depletion		Diversion	Depletion		Diversion	Depletion
Fuels:													
Natural gas.....million cubic feet..	Program-A.	112	(1)	(1)	150	(1)	(1)	220	(1)	(1)	289	(1)	(1)
do.....	Program-B.	112	(1)	(1)	183	(1)	(1)	305	(1)	(1)	426	(1)	(1)
Petroleum:													
Production.....thousand barrels..	Program-A.	2,627	(1)	(1)	3,213	(1)	(1)	4,235	(1)	(1)	5,204	(1)	(1)
do.....	Program-B.	2,627	(1)	(1)	3,507	(1)	(1)	5,012	(1)	(1)	6,452	(1)	(1)
Drilling.....thousand feet..	Program-A.	168	43	43	216	56	56	288	74	74	360	93	93
do.....	Program-B.	168	43	43	243	63	63	342	88	88	441	114	114
Secondary recovery2/...thousand barrels..	Program-A.	67	8	8	108	13	12	199	24	23	313	37	36
do.....	Program-B.	67	8	8	122	14	14	236					
Summary, fuels.....	Program-A.		51	51	-	69	68	-	98	97	-	130	129
do.....	Program-B.		51	51	-	77	77	-	116	115	-	160	158
Nonmetallic minerals:													
Cement3/													
Masonry.....280-pound barrels..	Program-A.	W	6	3	10,000	6	3	10,900	6	5	13,000	8	3
do.....	Program-B.	W	6	3	10,800	6	3	12,400	7	3	14,700	9	4
Portland....thousand 376-pound barrels..	Program-A.	W	244	105	410	259	105	448	261	112	529	308	132
do.....	Program-B.	W	244	105	442	258	111	508	296	127	601	350	150
Clays3/.....short tons..	Program-A.	303,004	134	16	362,400	160	19	517,700	229	27	766,200	338	40
do.....	Program-B.	303,004	134	16	450,400	199	23	828,400	366	43	1,309,000	579	68
Sand and gravel4/.....thousand short tons..	Program-A.	3,451	784	422	5,350	732	410	9,694	808	452	4,303	954	534
do.....	Program-B.	3,451	784	422	5,651	798	447	4,189	916	515	4,058	1,084	607
Stone.....do.....	Program-A.	W	16	1	60	15	1	66	17	1	78	20	1
do.....	Program-B.	W	16	1	65	16	1	74	119	1	88	22	2
Summary, nonmetallic minerals.....	Program-A.		1,154	547	-	1,152	536	-	1,521	595	-	1,628	710
do.....	Program-B.		1,154	547	-	1,277	585	-	1,604	687	-	2,041	881
Total, all minerals.....	Program-A.	-	1,205	598	-	1,221	604	-	1,619	692	-	1,758	839
do.....	Program-B.	-	1,205	598	-	1,354	662	-	1,720	802	-	2,201	989

W Withheld to avoid disclosing company confidential information.
1/ No significant water use.
2/ Assume 40 percent of production is by secondary recovery in 1969, 50 percent in 1980, 60 percent in 2000, and 67 percent in 2020.
3/ Clay projections are based on national trends.
4/ Assume 95 percent of production will be washed.

Table 19 - WRPA 4, Projections of Land Use Needs for Mineral Resources, Acres

Commodity	Projection	1969	1980	2000	2020
Fuels.....	Program-A.	100	100	125	150
Do.....	Program-B.	100	125	150	200
Nonmetallic minerals....	Program-A.	3,200	3,300	3,850	5,100
Do.....	Program-B.	3,200	3,700	5,200	7,200
Total, all minerals.....	Program-A.	3,300	3,400	3,975	5,250
Do.....	Program-B.	3,300	3,825	5,350	7,400



WRPA 5

W R P A 5

MINERAL RESOURCE BASE

WRPA 5 in south-central Arkansas and north-central Louisiana is bordered by out-of-area counties and parishes in Arkansas and Louisiana. The 18 counties and 12 parishes in the area are as follows:

ARKANSAS
- Ashley
- Bradley
- Calhoun
- Clark
- Cleveland
- Dallas
- Drew
- Garland
- Grant
- Hempstead
- Hot Spring
- Jefferson
- Lincoln
- Montgomery
- Nevada
- Ouachita
- Pike
- Union

LOUISIANA
- Avoyelles
- Caldwell
- Catahoula
- Claiborne
- Grant
- Jackson
- La Salle
- Lincoln
- Ouachita
- Rapides
- Union
- Winn

Oil or gas is produced in about two-thirds of the counties and parishes, and the resource base, particularly in the southern part of the area, is excellent. Undeveloped lignite deposits exist in several parts of the area, and their probable future utilization should be noted. Nonmetallic minerals are produced in almost all the counties and parishes in any given year, and the resource base generally is sound. Vanadium is produced in Garland County, Ark., and the resource base is believed to be sufficient to support projected output through 2020.

Mineral Fuels

Petroleum

Crude oil is produced in all the Louisiana parishes in the area and in six of the southern Arkansas counties (Bradley, Calhoun, Hempstead, Nevada, Ouachita, and Union). Reserve data for WRPA 5 are not readily available.

During the period 1956-69, WRPA 5 produced about 5.5 percent of the crude oil in the region. Assuming that the area contains a similar share of the total estimated resource, WRPA 5 would have approximately 7,550 million barrels of oil remaining (table 3). Total petroleum output through 2020 at the high level of production would be about 2,200 million barrels. The crude oil base, therefore, seems ample to supply the output projected through 2020.

Natural Gas

Natural gas is recovered in almost all of the Louisiana parishes and in Union County, Ark. Most of the natural gas is produced in the northern Louisiana parishes. The future for gas output in southern Arkansas is generally viewed by informed petroleum industry sources as not particularly promising; therefore, it is likely that by 1980-2000 most marketed natural gas will be produced in the Louisiana portion of the area.

WRPA 5 produced about 5.4 percent of the natural gas output in the region during the 1956-69 interval. If the area contains a similar share of the region's total estimated resource, WRPA 5 would have about 33 trillion cubic feet of gas remaining (table 3). Cumulative gas output through 2020 would be approximately 14 trillion cubic feet at the Program B level of production. The natural gas resource base, therefore, seems sound.

Metallic Minerals

Vanadium

Vanadium ore is produced from open pit mines and processed into vanadium oxide concentrate in Garland County, Ark. The resource base is sufficient to support output projections through 2020.

Nonmetallic Minerals

Barite

Barite is produced in Hot Spring County, Ark., for use in drilling muds used for oil and gas wells. The resource base is believed to be sufficient to satisfy the moderate growth in output projected through 2020.

Bromine

Bromine is recovered from brine produced from the Smackover limestone in Union County, Ark. Reserves are not quantitatively estimated. Considering the extent of the Smackover limestone in the area and the moderate rate of production, however, the resource base seems quite sufficient to assure projected output through 2020.

Clays, Gypsum, Sand, Gravel, and Stone

Construction minerals are produced in essentially all counties and parishes in WRPA 5 in any given year (Caldwell Parish, however, rarely records anything but oil and gas output). Although some clay is produced for chemical industry use, most of it is used for construction purposes. Quality of the construction minerals varies, but the resource base in the area is huge; therefore, no supply problems are anticipated through 2020.

Aerial view of vanadium mill in Garland County, Ark.

PRESENT MINERAL PRODUCTION

Mineral output in WRPA 5 is dominated by the petroleum industry, although a wide variety of nonmetallic minerals is produced. Oil and gas should continue to overshadow other mineral production through 2020, but nonmetals production is expected to increase at a greater rate.

In 1969, total value of mineral output in the area was about $200 million. Mineral fuels made up $155 million or about 78 percent of this total.

Table 20 lists the mineral production in WRPA 5 by commodity, unit of production, quantity, and value (in current dollars) for the years 1956, 1963, and 1969, and summarizes quantity and value for the years 1956-69, inclusive.

PROJECTIONS OF MINERAL PRODUCTION AND RELATED WATER AND LAND NEEDS

Projections of Mineral Production

Minerals output in WRPA 5 is expected to increase through 2020. Projected value of mineral fuels increases from $155 million in 1969 to $233-322 million in 2020, a 50-110 percent increase. Metallic and nonmetallic minerals are foreseen to increase from about $36 million in 1969 to $62-98 million in 2020, about a 70-170 percent increase.

Projections for individual minerals and summaries for the years 1980, 2000, and 2020 are listed in table 21. Data are projected in the specific unit of production for each of the minerals, and all values are in terms of 1967 dollars.

Projections of Water and Land Needs

Mineral industry in WRPA 5 diverted an estimated 61,600 acre-feet of water and depleted about 9,800 acre-feet of this supply in 1969. Based upon projected increases in mineral output through 2020, diversions would rise to 100,900-161,400 acre-feet, an increase of 65-160 percent. During the same interval, depletions would climb to about 20,600-28,800 acre-feet, an increase of 110-190 percent.

Projections of water needs--both diversions and depletions--for the production of individual mineral commodities and summary totals for the years 1980, 2000, and 2020 are listed in table 22.

Table 20 - WRPA 5, Mineral Production, 1956, 1963, 1969, and Total 1956-1969
(Values in thousand current dollars)

Commodity, unit of production	1956		1963		1969		Total 1956 - 1969	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Abrasives.....short tons..	151	$37	W	W	W	W	30,091	$2,001
Barite, crude.....do....	486,254	4,256	W	W	W	W	3,844,652	38,280
Bromine.....thousand pounds..	0	0	W	W	W	W	335,331	73,726
Clays.....short tons..	W	W	W	W	W	W	6,139,404	11,011
Gem stones.....pounds..	NA	25	8,093	$42	NA	$24	NA	345
Gypsum, crude.....short tons..	W	W	W	W	W	W	3,021,131	8,290
Iron ore.....long tons..	0	0	W	W	0	0	120,781	807
Lime.....short tons..	0	0	W	W	W	W	178,677	3,481
Manganese.....do....	0	0	0	0	0	0	1,470	114
Mercury.....76-pound flask..	0	0	0	0	0	0	350	170
Natural gas.....million cubic feet..	199,790	22,668	253,425	46,149	155,146	29,770	2,777,916	482,776
Natural gas liquids.....thousand barrels..	5,966	17,357	6,885	15,622	13,370	35,865	92,910	255,682
Petroleum.....do....	29,857	83,743	22,637	72,932	31,003	98,392	405,915	1,215,787
Salt.....thousand short tons..	W	W	W	W	0	0	873	11,789
Sand and gravel.....do....	4,445	5,050	3,774	4,945	6,617	7,270	69,527	86,146
Stone.....do....	450	1,025	W	W	W	W	6,864	18,293
Vanadium.....short tons..	0	0	0	0	W	W	W	W
Total.....		136,928		149,114		W		1/2,200,000

W Withheld to avoid disclosing company confidential information.
NA Not available.
1/ Approximate total.

Table 21 - WRPA 5, Mineral Production and Value, 1969, and Projections for 1980, 2000, and 2020
(Thousand 1967 dollars adjusted by Bureau of Mines price indexes for selected minerals)

Commodity, unit of production	Projection	1969		1980		2000		2020	
		Production	Value	Production	Value	Production	Value	Production	Value
Fuels:									
Natural gas.....million cubic feet..	Program-A..	133,146	$28,532	217,000	$39,028	231,000	$42,504	245,000	$45,080
do.....do....	Program-B..	155,146	28,532	267,300	49,128	330,000	60,720	394,000	72,496
Natural gas liquids.....thousand barrels..	Program-A..	13,370	33,291	18,770	46,737	19,901	49,775	21,190	52,765
do.....do....	Program-B..	13,370	33,291	23,000	57,494	28,548	71,077	34,080	84,859
Petroleum.....do....	Program-A..	31,005	93,130	35,250	100,527	58,450	117,213	44,190	135,114
do.....do....	Program-B..	31,005	93,130	35,200	106,594	44,270	135,111	53,800	165,000
Summary, fuels.....	Program-A..	-	154,953	-	187,192	-	209,492	-	232,957
do.....	Program-B..	-	154,953	-	213,216	-	266,908	-	322,355
Metallic minerals:									
Vanadium ore.....short tons..	Program-A..	W	W	1,000	3,080	1,000	3,080	1,000	3,080
do.....do....	Program-B..	W	W	1,300	4,020	2,000	6,160	3,000	9,240
Summary, metallic minerals.....	Program-A..	-	W	-	3,080	-	3,080	-	3,080
do.....	Program-B..	-	W	-	4,020	-	6,160	-	9,240
Nonmetallic minerals:									
Abrasives.....short tons..	Program-A..	W	W	7,500	544	7,000	508	6,500	472
do.....do....	Program-B..	W	W	8,000	580	8,000	580	8,000	580
Barite, crude.....do....	Program-A..	W	W	213,800	4,917	220,200	5,065	227,800	5,239
do.....do....	Program-B..	W	W	294,600	6,776	434,700	9,998	576,500	13,256
Bromine.....thousand pounds..	Program-A..	W	W	90,183	21,644	122,562	29,415	154,383	37,052
do.....do....	Program-B..	W	W	107,060	25,694	170,804	40,993	233,068	56,152
Clays.....short tons..	Program-A..	W	W	539,525	612	598,246	719	490,337	887
do.....do....	Program-B..	W	W	562,300	655	440,675	705	566,150	1,024
Gem stones.....pounds..	Program-A..	NA	35	NA	35	NA	35	NA	35
do.....do....	Program-B..	NA	35	NA	35	NA	35	NA	35
Gypsum, crude.....short tons..	Program-A..	W	W	185,370	581	217,017	681	264,165	829
do.....do....	Program-B..	W	W	197,255	619	240,683	755	303,303	958
Lime.....do....	Program-A..	W	W	6,067	120	7,127	141	8,811	175
do.....do....	Program-B..	W	W	6,430	129	7,879	156	10,171	201
Sand and gravel.....thousand short tons..	Program-A..	6,617	8,805	6,883	9,178	8,045	10,714	9,733	12,911
do.....do....	Program-B..	6,617	8,805	7,504	9,725	8,950	11,920	11,240	14,912
Stone.....do....	Program-A..	W	W	522	1,224	612	1,435	750	1,758
do.....do....	Program-B..	W	W	537	1,305	678	1,500	866	2,030
Summary, nonmetallic minerals.....	Program-A..	-	34,060	-	38,855	-	48,713	-	59,358
do.....	Program-B..	-	34,060	-	45,318	-	66,822	-	80,128
Total, all minerals.....	Program-A..	-	W	-	229,127	-	261,285	-	295,395
do.....	Program-B..	-	W	-	263,354	-	339,890	-	420,723

NA Not available.
W Withheld to avoid disclosing company confidential information.

Table 22 - WRPS 5, Projection of Mineral Production and Water Needs, 1969, 1980, 2000, and 2020

Commodity, unit of production	Projection	1969			1980			2000			2020		
		Production	Water needs, acre-feet		Production	Water needs, acre-feet		Production	Water needs, acre-feet		Production	Water needs, acre-feet	
			Diversion	Depletion		Diversion	Depletion		Diversion	Depletion		Diversion	Depletion
Fuels:													
Natural gas.....million cubic feet..	Program-A..	155,146	(1)	(1)	217,000	(1)	(1)	231,000	(1)	(1)	245,000	(1)	(1)
do....	Program-B..	155,146	(1)	(1)	267,300	(1)	(1)	330,000	(1)	(1)	304,000	(1)	(1)
Natural gas liquids.....thousand barrels..	Program-A..	13,570	50,124	5,100	18,770	70,369	4,353	19,990	74,945	4,636	21,190	79,441	4,914
do....	Program-B..	13,570	50,124	5,100	25,090	86,564	5,355	28,345	107,015	6,620	34,080	127,766	7,903
Petroleum:													
Production.....do....	Program-A..	31,005	(1)	(1)	33,250	(1)	(1)	38,450	(1)	(1)	44,100	(1)	(1)
do....	Program-B..	31,005	(1)	(1)	38,200	(1)	(1)	44,279	(1)	(1)	55,800	(1)	(1)
Drilling.....thousand feet..	Program-A..	4,124	1,066	1,066	4,180	1,078	1,078	4,476	1,157	1,157	4,877	1,256	1,256
do....	Program-B..	4,124	1,066	1,066	4,377	1,127	1,127	5,091	1,317	1,317	5,880	1,513	1,513
Secondary recovery2/...thousand barrels..	Program-A..	12,402	5,855	5,506	16,625	4,832	4,767	26,531	7,847	7,745	38,363	11,469	11,319
do....	Program-B..	12,402	5,855	5,506	17,000	5,128	5,059	30,347	9,098	8,939	46,806	14,022	13,840
Summary, fuels.....	Program-A..	-	64,745	7,672	-	76,279	10,198	-	83,147	13,538	-	92,166	17,489
do....	Program-B..	-	64,745	7,672	-	92,819	11,541	-	117,390	16,876	-	143,301	23,256
Metallic minerals:													
Vanadium.....short tons..	Program-A..	W	1,100	540	1,000	1,306	549	1,000	1,306	549	1,000	1,306	549
do....	Program-B..	W	1,100	540	1,500	1,959	823	2,000	2,612	1,097	3,000	3,918	1,646
Summary, metallic minerals.....	Program-A..	-	1,100	540	-	1,306	549	-	1,306	549	-	1,306	549
do....	Program-B..	-	1,100	540	-	1,959	823	-	2,612	1,097	-	3,918	1,646
Nonmetallic minerals:													
Bryozoa3/.....short tons..	Program-A..	W	27	1	7,500	27	1	7,000	25	1	6,500	23	1
do....	Program-B..	W	27	1	8,000	29	1	8,000	29	1	8,000	29	1
Barite, crude.....do....	Program-A..	W	3,623	300	213,800	5,946	506	220,200	3,697	316	227,800	3,825	326
do....	Program-B..	W	3,623	300	294,000	4,946	422	434,700	7,299	623	575,200	9,663	825
Bromine.....thousand pounds..	Program-A..	W	466	466	90,183	581	581	122,562	790	790	161,783	994	994
do....	Program-B..	W	466	466	107,460	680	680	170,804	1,100	1,100	253,068	1,597	1,597
Clays.....short tons..	Program-A..	W	145	18	339,323	150	18	308,246	176	21	406,357	216	25
do....	Program-B..	W	145	18	362,400	160	19	440,675	195	23	566,156	250	30
Gem stones.....pounds..	Program-A..	NA	(1)	(1)	NA	(1)	(1)	NA	(1)	(1)	NA	(1)	(1)
do....	Program-B..	NA	(1)	(1)	NA	(1)	(1)	NA	(1)	(1)	NA	(1)	(1)
Gypsum, crude.....short tons..	Program-A..	W	27	17	185,370	45	27	217,017	65	41	264,165	79	50
do....	Program-B..	W	27	17	197,255	47	28	240,643	73	47	305,305	92	58
Lime.....do....	Program-A..	W	1	1	6,067	1	1	7,117	1	1	8,471	1	1
do....	Program-B..	W	1	1	6,400	1	1	7,479	1	1	10,171	1	1
Sand and gravel.....thousand short tons..	Program-A..	6,017	1,446	809	6,883	1,608	841	8,043	1,755	988	9,233	2,124	1,192
do....	Program-B..	6,017	1,446	809	7,304	1,592	896	8,939	1,953	1,099	11,240	2,460	1,379
Stone.....do....	Program-A..	W	129	9	522	133	10	612	156	11	750	191	14
do....	Program-B..	W	129	9	557	142	10	678	172	13	866	221	16
Summary, nonmetallic minerals.....	Program-A..	-	5,764	1,621	-	6,580	1,785	-	6,664	2,168	-	7,453	2,602
do....	Program-B..	-	5,764	1,621	-	7,804	2,062	-	10,822	2,901	-	14,225	3,817
Total, all minerals.....	Program-A..	-	61,609	9,842	-	83,974	12,532	-	91,017	16,255	-	100,925	20,640
do....	Program-B..	-	61,609	9,842	-	102,382	14,426	-	130,824	20,874	-	161,442	28,719

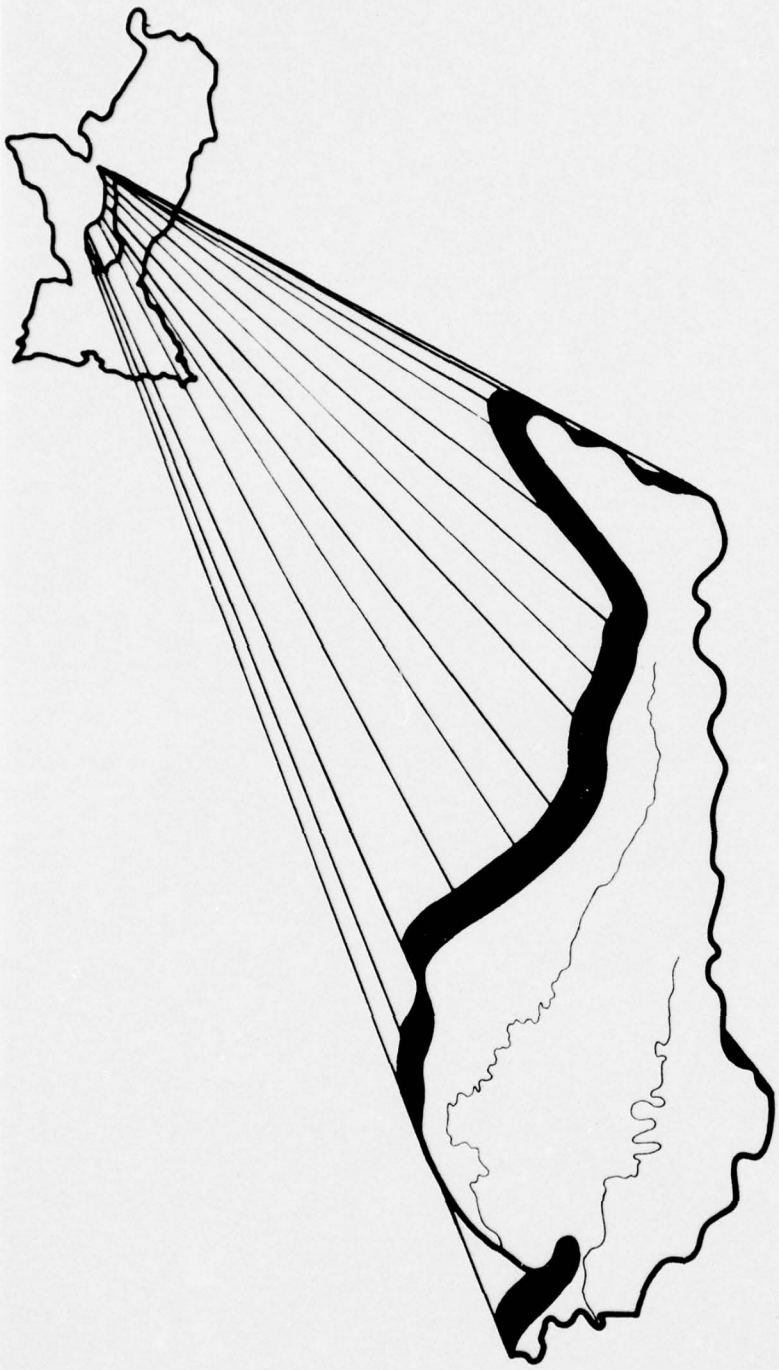
(1) Not available. W Withheld to avoid disclosing company confidential information.
(1) No significant water use.
2/ About 40 percent of production is by secondary recovery in 1969, 50 percent in 1980, 60 percent in 2000, and 87 percent in 2020.
3/ Includes trepoli.

Land use in WRPA 5 by mineral industry, totaling about 8,400 acres in 1969, is a small part of total acreage in the area. Such land needs are expected to increase to about 10-15 thousand acres by 2020, a 20-80 percent increase.

Projections of estimated land needs for the production of minerals and summaries for the years 1980, 2000, and 2020 are listed in table 23.

Table 23 - WRPA 5, Projections of Land Use Needs for Mineral Resources, Acres

Commodity	Projection	1969	1980	2000	2020
Fuels.....	Program-A.	4,400	4,600	4,800	5,000
Do.....	Program-B.	4,400	4,950	5,550	6,200
Metallic minerals.....	Program-A.	1,000	1,000	1,000	1,000
Do.....	Program-B.	1,000	1,500	2,000	3,000
Nonmetallic minerals...	Program-A.	3,000	3,050	3,620	4,250
Do.....	Program-B.	3,000	3,260	4,200	5,350
Total, all minerals....	Program-A.	8,400	8,650	9,420	10,250
Do.....	Program-B.	8,400	9,710	11,750	14,550



WRPA 6

W R P A 6

MINERAL RESOURCE BASE

WRPA 6 is centrally located in the region and is comprised of counties in southeast Arkansas and parishes in northeast Louisiana. It is bordered by out-of-area counties and parishes in Arkansas and Louisiana on the north, west, and south, and by Mississippi on the east. The two counties and eight parishes in the area are as follows:

ARKANSAS	Franklin
Chicot	Madison
Desha	Morehouse
LOUISIANA	Richland
Concordia	Tensas
East Carroll	West Carroll

Oil or gas is produced in all of the Louisiana parishes. Sand and gravel are produced in small quantities in a few of the counties and parishes in any given year. Geologic conditions favor substantially increased output of natural gas and moderately increased output of crude oil through 2020. The resource base of sand and gravel, although variable in quality, is essentially unlimited.

Mineral Fuels

Petroleum

Crude oil has been produced in most of the Louisiana parishes in WRPA 6 in recent years. Reserve data for the area are not readily available.

During the 1956-69 interval, WRPA 6 produced about 2.7 percent of the crude oil in the region. Assuming that a similar share of the total regional resource exists in WRPA 6, the area would have about 3,710 million barrels of oil remaining (table 3). Cumulative petroleum production through 2020 at the Program B level of output would be less than 1 billion barrels; therefore, the estimated resource base would be quite capable of supporting projected output through 2020.

Natural Gas

All of the parishes in the Louisiana portion of the area have recorded natural gas output in recent years. Reserve data for WRPA 6 are not readily available.

Natural gas production in WRPA 6 amounted to about 1.4 percent of regional output during the 1956-69 period. Assuming that this production

is indicative of the resource base, 8.5 trillion cubic feet of gas would remain. The cumulative output of natural gas through 2020, influenced by a recent strong uptrend, would approximate 11 trillion cubic feet, thereby exceeding the estimated resource by about a 30-percent margin. It is probable, then, based upon the methodology used to estimate the resource base, that exhaustion of the natural gas resource would occur in WRPA 6 sometime between 2000 and 2020. Countering this negative statistical factor is a positive physical factor--namely, the area is underlain by sediments 20,000 feet thick, and much of the area has not been probed. In summary, the natural gas resource base in WRPA 6, may prove troublesome in the long-range future--possibly soon after 2000.

Nonmetallic Minerals

Sand and Gravel

Sand and gravel are produced in small amounts in both the Arkansas and Louisiana parts of the area. The resource base, although of inferior quality in some places, is essentially inexhaustible in WRPA 6.

PRESENT MINERAL PRODUCTION

Oil and gas output, for all practical purposes, constitutes the mineral industry in WRPA 6. In 1969, total value of mineral output in the area was about $68 million, and oil and gas values made up 99.5 percent of this total. The remainder was sand and gravel output.

Table 24 lists the mineral production in WRPA 6 by commodity, unit of production, quantity, and value (in current dollars) for the years 1956, 1963, and 1969, and summarizes quantity and value for the years 1956-69, inclusive.

PROJECTIONS OF MINERAL PRODUCTION AND RELATED WATER AND LAND NEEDS

Projections of Mineral Production

Minerals output in WRPA 6 is expected to increase through 2020. Natural gas should show the sharpest growth, increasing by about 100 percent through 2000, and possibly some additional growth through the remaining 20 years. Output of crude oil should be up some 80 percent by 2020. Sand and gravel production should grow moderately through 2020.

Projections for individual minerals and summaries for the years 1980, 2000, and 2020 are listed in table 25. Data are projected in the

Table 24 - WRPA 6, Mineral Production, 1956, 1963, 1969, and Total 1956-1969
(Values in thousand current dollars)

Commodity, unit of production	1956		1963		1969		Total 1956 - 1969	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Natural gas.....million cubic feet..	36,675	$4,181	41,226	$8,163	112,813	$21,660	747,057	$132,142
Natural gas liquids.....thousand barrels..	464	1,091	1,676	3,816	1,600	4,208	16,157	39,580
Petroleum.....do....	14,953	43,845	13,727	42,871	12,729	42,066	201,198	633,513
Sand and gravel.....thousand short tons..	269	171	469	452	293	321	5,746	8,218
Total.....		49,288		55,302		68,255		813,453

Table 25 - WRPA 6, Mineral Production and Value, 1969, and Projections for 1980, 2000, and 2020
(Thousand 1967 dollars adjusted by Bureau of Mines price indexes for selected minerals)

Commodity, unit of production	Projection	1969		1980		2000		2020	
		Production	Value	Production	Value	Production	Value	Production	Value
Fuels:									
Natural gas.....million cubic feet..	Program-A.	112,813	$20,870	115,000	$21,275	183,000	$33,855	252,000	$46,620
Do.....do....	Program-B.	112,813	20,870	128,000	25,680	225,000	41,625	320,000	59,200
Natural gas liquids.....thousand barrels..	Program-A.	1,600	4,000	1,630	4,075	2,600	6,500	3,600	9,000
Do.....do....	Program-B.	1,600	4,000	1,820	4,550	3,200	8,000	4,650	11,575
Petroleum.....do....	Program-A.	12,729	39,714	13,000	40,560	13,800	43,056	14,700	45,864
Do.....do....	Program-B.	12,729	39,714	15,500	48,360	19,000	59,280	22,800	71,136
Summary, fuels.....	Program-A.	-	64,584	-	65,910	-	83,411	-	101,484
Do.....	Program-B.	-	64,584	-	78,590	-	108,905	-	141,711
Nonmetallic minerals:									
Sand and gravel.....thousand short tons..	Program-A.	293	363	271	336	271	336	292	362
Do.....do....	Program-B.	293	363	280	358	285	355	321	398
Summary, nonmetallic minerals.....	Program-A.	-	363	-	336	-	336	-	362
Do.....	Program-B.	-	363	-	358	-	355	-	398
Total, all minerals.....	Program-A.	-	64,947	-	66,246	-	83,747	-	101,846
Do.....	Program-B.	-	64,947	-	78,948	-	109,258	-	142,109

specific unit of production for each of the minerals, and all values are in terms of 1967 dollars.

Projections of Water and Land Needs

Mineral industry diverted an estimated 7,900 acre-feet and depleted 2,300 acre-feet of water in WRPA 6 during 1969. Through 2020, diversions are expected to rise to 17,900-23,800 acre-feet, an increase of about 125-200 percent. Depletions would climb to 5,100-7,700 acre-feet, an increase of about 120-235 percent.

Projections of water diversions and depletions for the production of individual mineral commodities, together with summary totals for the years 1980, 2000, and 2020, are listed in table 26.

Land use in WRPA 6 by mineral industry is negligible. In 1969, a total of about 1,800 acres was occupied, and this use is expected to increase to about 3,600 to 4,700 acres in 2020, a 100-160 percent increase.

Projections of estimated land needs for the production of minerals and summaries for the years 1980, 2000, and 2020 are listed in table 27.

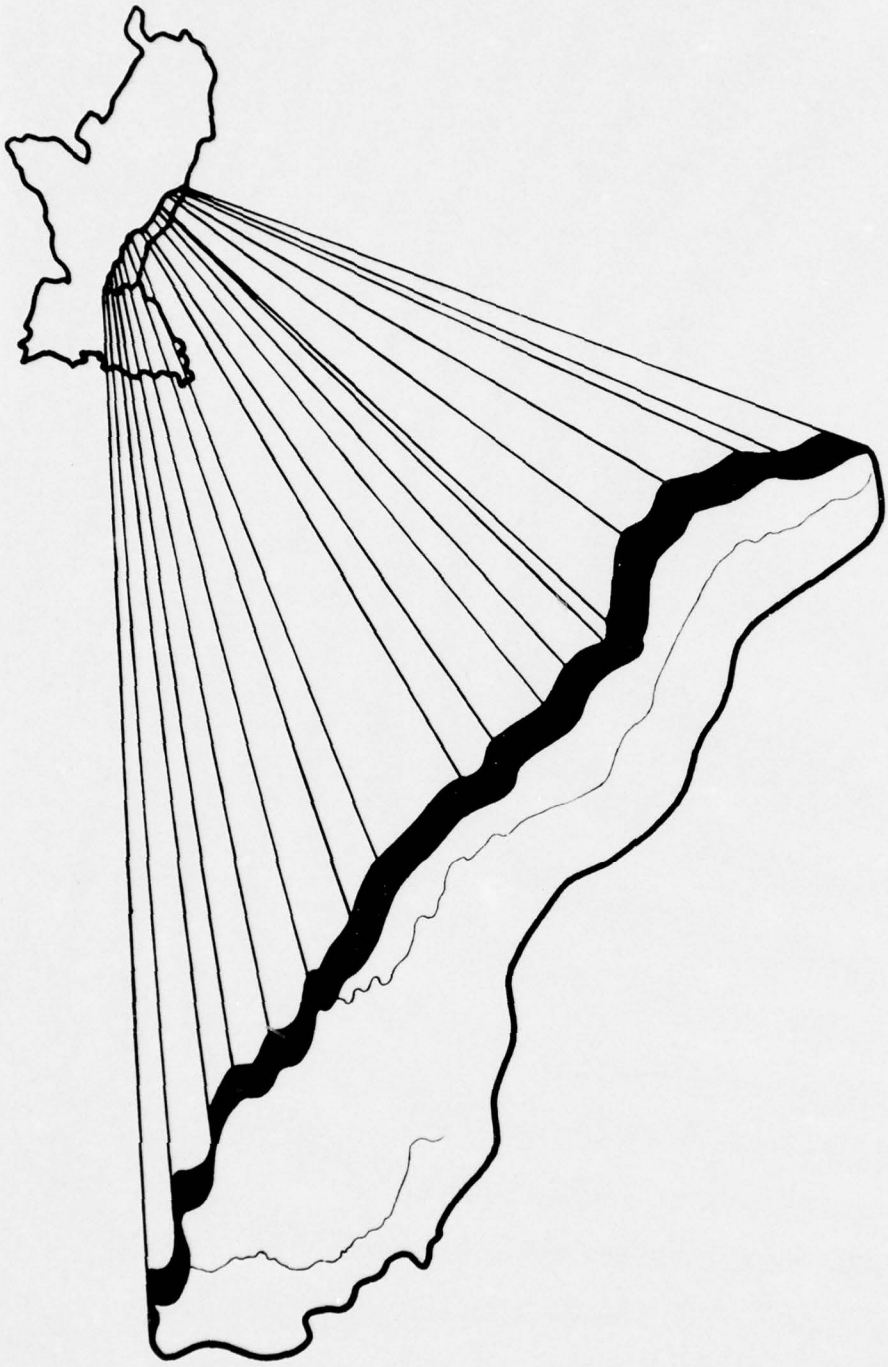
Table 26 - WRPA 6, Projections of Mineral Production and Water Needs, 1960, 1980, 2000, and 2020

Commodity, unit of production	Projection	1960			1980			2000			2020		
		Production	Water needs, acre-feet		Production	Water needs, acre-feet		Production	Water needs, acre-feet		Production	Water needs, acre-feet	
			Diversion	Depletion		Diversion	Depletion		Diversion	Depletion		Diversion	Depletion
Fuels:													
Natural gas.....million cubic feet..	Program-A.	112,813	(1)	(1)	115,000	(1)	(1)	183,000	(1)	(1)	252,000	(1)	(1)
do....	Program-B.	112,813	(1)	(1)	158,000	(1)	(1)	225,000	(1)	(1)	320,000	(1)	(1)
do....	Program-A.	1,600	5,908	371	1,630	6,111	378	2,600	9,747	603	3,600	13,496	835
Natural gas liquids.....thousand barrels..	Program-B.	1,600	5,908	371	1,820	6,825	422	3,209	11,987	742	4,550	17,058	1,055
do....													
Petroleum:													
do....	Program-A.	12,729	(1)	(1)	15,000	(1)	(1)	15,800	(1)	(1)	14,700	(1)	(1)
Production.....do....	Program-B.	12,729	(1)	(1)	15,500	(1)	(1)	19,000	(1)	(1)	20,800	(1)	(1)
do....													
Drilling.....thousand feet..	Program-A.	1,145	296	296	1,170	302	302	1,230	323	323	1,350	345	345
do....	Program-B.	1,145	296	296	1,400	361	361	1,710	441	441	2,050	529	529
Secondary recovery2/...thousand barrels...	Program-A.	3,092	1,581	1,361	6,500	2,018	1,393	9,522	2,957	2,019	12,780	3,971	3,021
do....	Program-B.	3,092	1,581	1,361	7,750	2,406	2,376	15,110	4,071	4,020	15,836	6,150	6,082
Summary, fuels.....	Program-A.	-	7,873	2,228	-	8,431	2,673	-	13,027	3,845	-	17,810	5,099
do....	Program-B.	-	7,873	2,228	-	9,390	5,159	-	16,509	9,203	-	23,736	7,666
Nonmetallic minerals:													
Sand and gravel.....thousand short tons..	Program-A.	293	64	36	371	59	33	271	59	33	292,000	64	36
do....	Program-B.	293	64	36	280	63	35	285	62	35	321,000	70	39
do....													
Summary, nonmetallic minerals.....	Program-A.	-	64	36	-	59	33	-	59	33	-	64	36
do....	Program-B.	-	64	36	-	63	35	-	62	35	-	70	39
Total, all minerals.....	Program-A.	-	7,937	2,264	-	8,490	2,673	-	13,086	3,878	-	17,874	5,135
do....	Program-B.	-	7,937	2,264	-	9,453	5,194	-	16,571	9,238	-	23,806	7,705

1/ No significant water use.
2/ Assume 40 percent of production is by secondary recovery in 1960, 50 percent in 1980, 60 percent in 2000, and 85 percent in 2020.

Table 27 - WRPA 6, Projections of Land Use Needs for Mineral Resources, Acres

Commodity	Projection	1969	1980	2000	2020
Fuels.....	Program-A.	1,800	1,900	2,700	3,600
Do.....	Program-B.	1,800	2,150	3,375	4,650
Nonmetallic minerals....	Program-A.	30	30	30	30
Do.....	Program-B.	30	30	30	40
Total, all minerals.....	Program-A.	1,830	1,930	2,730	3,630
Do.....	Program-B.	1,830	2,180	3,405	4,690



WRPA 7

W R P A 7

MINERAL RESOURCE BASE

WRPA 7 is located in central and southwest Mississippi. It is bordered on the southwest by Louisiana and elsewhere by out-of-area counties in Mississippi. The 10 counties in the area are as follows:

Adams	Claiborne	Montgomery
Attala	Franklin	Webster
Choctaw	Jefferson	Wilkinson
	Madison	

Crude oil or natural gas is produced in about half the counties in the area in any given year. Small quantities of clay, sand, and gravel are produced in a few counties for local use. The area possesses favorable geologic conditions for oil and gas accumulations, and increased output through 2020 is expected. The resource base for the nonmetallic minerals currently produced is strong.

Mineral Fuels

Petroleum and Natural Gas

Crude oil and natural gas have been produced in most of the counties in recent years, and the bulk of the output was recovered from the southwestern cluster of counties.

During the 1956-69 period, WRPA 7 recorded about 1.7 percent of the oil output and 0.4 percent of the gas output in the region. If it contains a parallel share of the region's resources, the area would have about 2,330 million barrels of oil and 2.5 trillion cubic feet of gas remaining (table 3). Total petroleum production through 2020 at the high rate of output would be about 1,500 million barrels, while gas output would be about 0.35 trillion cubic feet. The estimated resource base, therefore, appears quite capable of supplying the projected output through 2020.

Lignite

Discontinuous deposits of lignite exist in the central-Mississippi tier of counties. As in other areas of the Lower Mississippi Region, no development is projected for these deposits through 2020 in any particular area; however, some utilization within the Lower Mississippi Region is quite likely. Specific deposits to be put into production will be determined both by increased knowledge of the various lignite deposits and by developing regional demand for the lignite as a mineral fuel and possibly as feed material for the regional chemical industry.

Nonmetallic Minerals

Clay, Sand, and Gravel

Small amounts of clay, sand, and gravel are produced in the region to satisfy local needs. The resource base is ample to meet the modest volume of output anticipated through 2020.

PRESENT MINERAL PRODUCTION

The petroleum industry accounted for about $48 million of the approximate total $50 million in minerals output in 1969. Sand, gravel, and clay made up the remaining 3 percent of value of mineral production.

Table 28 lists the mineral production in WRPA 7 by commodity, unit of production, quantity, and value (in current dollars) for the years 1956, 1963, and 1969, and summarizes quantity and value for the years 1956-69, inclusive.

PROJECTIONS OF MINERAL PRODUCTION AND RELATED WATER AND LAND NEEDS

Projections of Mineral Production

Steady moderate growth in minerals output through 2020 is foreseen for WRPA 7. Oil and gas should maintain their dominant position throughout the period.

Projections for individual minerals and summaries for the years 1980, 2000, and 2020 are listed in table 29. Data are projected in the specific unit of production for each of the minerals, and all values are in terms of 1967 dollars.

Projections of Water and Land Needs

Water use in WRPA 7 in 1969 included an estimated 4,100 acre-feet of diversions and 4,000 acre-feet of depletions. By 2020, diversions are projected to increase to 9,900-12,200 acre-feet, up about 140-200 percent. Depletions would parallel this increase to 9,600-11,900 acre-feet, a rise in the same percentage range as diversions. Most of the water is used by the petroleum industry, principally in secondary recovery operations wherein water is injected into oil-bearing strata to augment recoveries.

Table 28 - WRPA 7, Mineral Production, 1956, 1963, 1969, and Total 1956-1969
(Values in thousand current dollars)

Commodity, unit of production	1956		1963		1969		Total 1956 - 1969	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Clays.....short tons..	2,813	$3	W	W	W	W	205,944	$1,828
Iron ore (usable).....long tons..	183	(1)	0	0	0	0	352	1
Natural gas.....million cubic feet..	NA	(2)	32,367	$5,826	3,364	$592	216,664	39,940
Natural gas liquids.....thousand barrels..	NA	(2)	174	371	65	140	1,763	4,109
Petroleum.....do....	NA	3/33,547	9,655	26,648	16,285	47,501	123,993	486,305
Sand and gravel.....thousand short tons..	489	757	401	609	862	980	7,087	10,184
Total.....		34,307		W		W		542,367

NA Not available.
1/ Less than 1/2 unit.
2/ Combined with petroleum.
3/ Includes natural gas and natural gas liquids.

Table 29 - WRPA 7, Mineral Production and Value, 1969, and Projections for 1980, 2000, and 2020
(Thousand 1967 dollars adjusted by Bureau of Mines price indexes for selected minerals)

Commodity, unit of production	Projection	1969		1980		2000		2020	
		Production	Value	Production	Value	Production	Value	Production	Value
Fuels:									
Natural gas.....million cubic feet..	Program-A	3,304	$576	4,149	$709	5,623	$961	7,063	$512
Do.....do....	Program-B	3,364	576	4,757	814	7,245	1,239	9,605	1,642
Natural gas liquids.....thousand barrels..	Program-A	65	160	118	288	190	465	262	643
Do.....do....	Program-B	65	160	119	291	193	471	266	650
Petroleum.....do....	Program-A	16,285	44,295	19,917	54,175	26,251	71,403	32,245	87,706
Do.....do....	Program-B	16,285	44,295	21,741	59,135	31,072	84,516	39,996	108,789
Summary, fuels.....	Program-A	-	45,031	-	55,172	-	72,829	-	89,556
Do.....	Program-B	-	45,031	-	60,240	-	86,226	-	111,081
Nonmetallic minerals:									
Clays.....short tons..	Program-A	W	W	11,300	108	12,800	122	15,100	144
Do.....do....	Program-B	W	W	12,500	119	14,900	142	17,700	169
Sand and gravel.....thousand short tons..	Program-A	862	1,224	885	1,251	1,000	1,414	1,185	1,675
Do.....do....	Program-B	862	1,224	978	1,382	1,163	1,644	1,388	1,962
Summary, nonmetallic minerals.....	Program-A	-	W	-	1,359	-	1,536	-	1,819
Do.....	Program-B	-	W	-	1,501	-	1,786	-	2,131
Total, all minerals.....	Program-A	-	W	-	56,531	-	74,365	-	91,375
Do.....	Program-B	-	W	-	61,741	-	88,012	-	113,212

W Withheld to avoid disclosing company confidential information.

Projections of water diversions and depletions for the production of individual mineral commodities and summary totals for the years 1980, 2000, and 2020 are listed in table 30.

Mineral industry land use in WRPA 7 is negligible. In 1969, approximately 800 acres was used, and future use is expected to increase to about 1,400-1,650 acres by 2020, a 75-105 percent increase.

Projections of estimated land needs for mineral industry for the years 1980, 2000, and 2020 are listed in table 31.

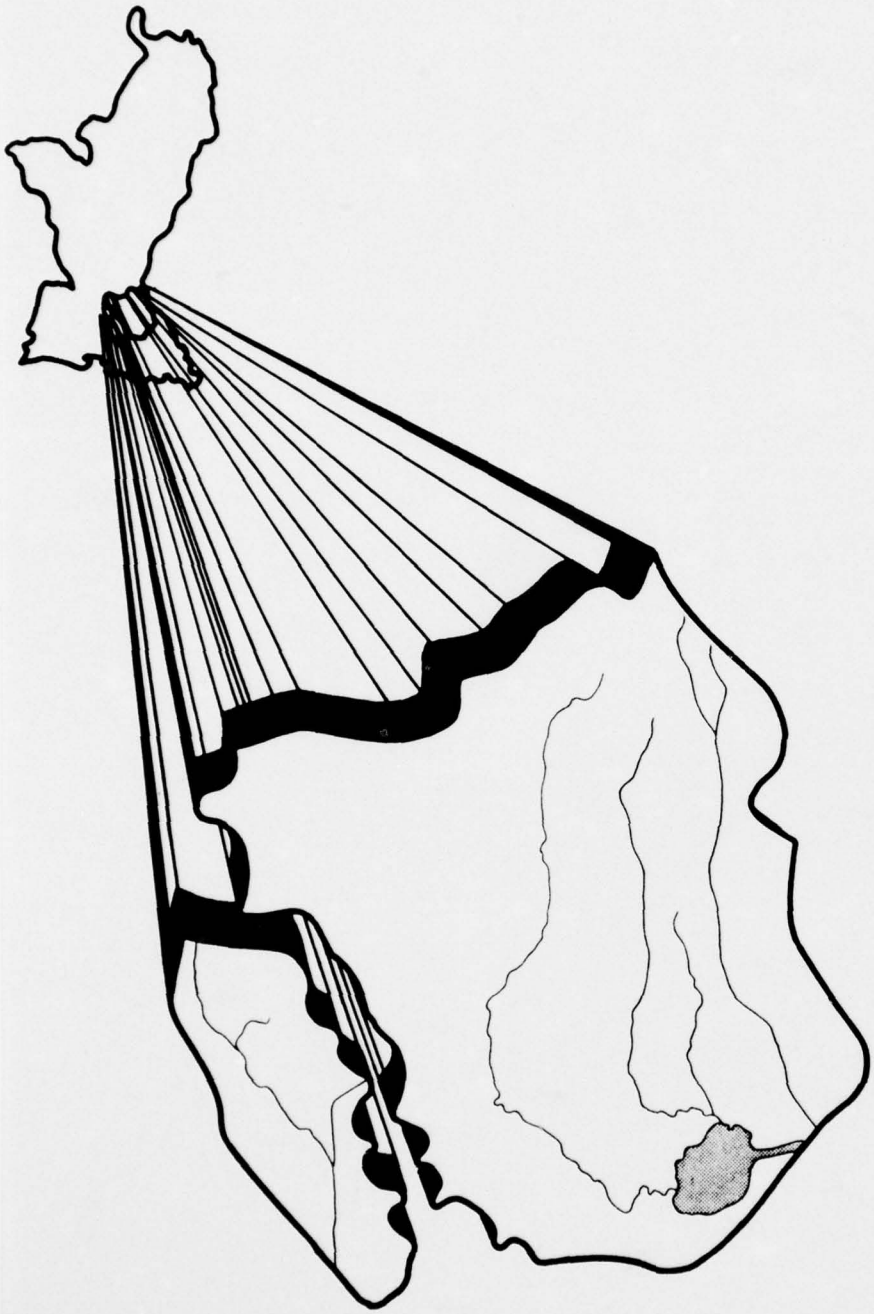
Table 30 - WRPA 7, Projections of Mineral Production and Water Needs, 1969, 1980, 2000, and 2020

Commodity, unit of production	Projection	1969			1980			2000			2020		
		Production	Water needs, acre-feet		Production	Water needs, acre-feet		Production	Water needs, acre-feet		Production	Water needs, acre-feet	
			Diversion	Depletion		Diversion	Depletion		Diversion	Depletion		Diversion	Depletion
Fuels:													
Natural gas.....million cubic feet..	Program-A	3,364	(1)	(1)	4,142	(1)	(1)	5,623	(1)	(1)	7,065	(1)	(1)
Do.....do....	Program-B	3,364	(1)	(1)	4,757	(1)	(1)	7,245	(1)	(1)	9,665	(1)	(1)
Natural gas liquids.....thousand barrels..	Program-A	65	36	27	118	66	48	190	106	79	262	146	108
Do.....do....	Program-B	65	36	27	119	66	49	193	107	80	266	147	109
Petroleum:													
Production.....do....	Program-A	16,285	(1)	(1)	19,017	(1)	(1)	26,251	(1)	(1)	32,245	(1)	(1)
Do.....do....	Program-B	16,285	(1)	(1)	21,741	(1)	(1)	31,072	(1)	(1)	39,990	(1)	(1)
Drilling.....thousand feet..	Program-A	12,068	5,110	5,110	14,764	5,804	5,804	19,455	5,013	5,013	23,403	6,169	6,169
Do.....do....	Program-B	12,068	5,110	5,110	16,120	4,154	4,154	23,035	5,936	5,936	28,047	5,540	5,540
Secondary recovery2/...thousand barrels..	Program-A	6,514	774	748	9,059	1,184	1,142	18,113	2,154	2,078	34,783	3,535	5,218
Do.....do....	Program-B	6,514	774	748	10,870	1,203	1,246	21,439	2,540	2,450	34,797	4,137	5,992
Summary, fuels.....	Program-A	-	3,920	3,885	-	5,054	4,994	-	7,273	7,170	-	9,841	9,496
Do.....	Program-B	-	5,520	5,885	-	5,513	5,449	-	8,592	8,476	-	11,324	11,749
Nonmetallic minerals:													
Clays.....short tons..	Program-A	W	5	1	11,300	5	1	12,800	6	1	15,100	7	1
Do.....do....	Program-B	W	5	1	12,200	6	1	14,000	7	1	17,700	8	1
Sand and gravel3/.....thousand short tons..	Program-A	862	188	106	885	193	108	1,000	219	122	1,185	260	146
Do.....do....	Program-B	862	188	106	978	214	120	1,163	255	143	1,388	303	170
Summary, nonmetallic minerals.....	Program-A	-	193	107	-	198	109	-	225	123	-	267	147
Do.....	Program-B	-	193	107	-	220	121	-	262	144	-	311	171
Total, all minerals4/.....	Program-A	-	4,113	3,992	-	5,252	5,103	-	7,498	7,293	-	10,108	9,643
Do.....	Program-B	-	4,113	3,992	-	5,733	5,570	-	8,854	8,619	-	12,635	11,911

W Withheld to avoid disclosing company confidential information.
1/ No significant water use.
2/ Assume 40 percent of production is by secondary recovery in 1969, 50 percent in 1980, 60 percent in 2000, and 87 percent in 2020.
3/ Assume 95 percent of production will be washed.
4/ No iron ore production is projected because it probably is not competitive with other sources.

Table 31 - WRPA 7, Projections of Land Use Needs for Mineral Resources, Acres

Commodity	Projection	1969	1980	2000	2020
Fuels.....	Program-A.	420	510	690	880
Do.....	Program-B.	420	570	800	1,040
Nonmetallic minerals.....	Program-A.	390	400	435	535
Do.....	Program-B.	390	430	510	620
Total, all minerals.....	Program-A.	810	910	1,125	1,415
Do.....	Program-B.	810	1,000	1,310	1,660



WRPA 8

W R P A 8

MINERAL RESOURCE BASE

WRPA 8 parishes are clustered about the city of Baton Rouge, La. It is bordered by out-of-area parishes on the east, south, and west, and by Mississippi counties on the north. The area is comprised of 10 parishes and 1 county as follows:

LOUISIANA	Iberville	W. Baton Rouge
Ascension	Livingston	W. Feliciana
E. Baton Rouge	Pointe Coupee	MISSISSIPPI
E. Feliciana	St. Helena	Amite
	Tangipahoa	

Petroleum or natural gas is produced in most of the parishes and in Amite County. Sand and gravel output also is recorded in most of the parishes, and clays, lime, and salt are also produced in the Louisiana portion of the area. The outlook for the petroleum industry is optimistic. The resource base for the nonmetallic minerals is very favorable.

Mineral Fuels

Petroleum

Crude oil has been produced in large quantities in recent years, and the western part of the area has contributed the bulk of the output.

During the 1956-69 period, WRPA 8 produced about 2.7 percent of the oil output in the region. Assuming that a similar share of the total regional resource exists in the area, WRPA 8 would have about 3,710 million barrels of crude oil remaining (table 3). Cumulative output through 2020 would be approximately 2,300 million barrels, well within the estimated total resource.

Natural Gas

Most of the oil-producing parishes and Amite County also record gas output. Value of the natural gas production (including natural gas liquids) has increased in recent years, but remains in the shadow of petroleum value. (In the late 1960's, crude oil accounted for about 70 percent of the petroleum industry's value of output.)

Natural gas production in WRPA 8 amounted to about 1.3 percent of the regional total during 1956-69. Assuming the output to be an indication of the resource potential, about 8 trillion cubic feet of natural gas would remain in place (table 3). Total gas output through 2020 would be 9.6 trillion cubic feet, somewhat in excess of the estimated

resource. Although geologic conditions are very favorable in the area, a resource problem does seem quite possible between 2000 and 2020.

Nonmetallic Minerals

Clay, Lime, Sand, and Gravel

Sand and gravel are mined in most of the parishes, and clays are produced in five parishes on a fairly steady basis. Lime is produced in E. Baton Rouge County and is used in the manufacture of cement for regional needs. Although quality and access are local problems, the resource base in the area is believed to be adequate to satisfy projected output through 2020.

Salt

Salt is produced in Ascension and Iberville Parishes. The resource base is immense.

PRESENT MINERAL PRODUCTION

In recent years the petroleum industry has accounted for about 70 percent of the value of mineral output in WRPA 8. Salt and the construction minerals make up the remainder of mineral production. No metallic minerals are produced.

Table 32 lists the mineral production in WRPA 8 by commodity, unit of production, quantity, and value (in current dollars) for the years 1956, 1963, and 1969, and summarizes quantity and value for the years 1956-69, inclusive.

PROJECTIONS OF MINERAL PRODUCTION AND RELATED WATER AND LAND NEEDS

Projections of Mineral Production

Minerals output in WRPA 8 is projected to increase sharply through 2020. Salt production should show the most pronounced increase--on the order of 600 percent. Crude oil output should increase by as much as 220 percent, and if the resource base of natural gas proves to be more promising than is currently assumed, gas output also could rise more than 200 percent by 2020. Nonmetallic minerals as a group in 1969 made up about 30 percent of the total value of mineral output, but by 2020 this group could represent 35 to 40 percent of value of minerals output.

Table 32 - WRPA 8, Mineral Production, 1956, 1963, 1969, and Total 1956-1969
(Values in thousand current dollars)

Commodity, unit of production	1956		1963		1969		Total 1956 - 1969	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Cement:								
Masonry.....280-pound barrels..	W	W	W	W	W	W	564,913	$1,614
Portland.....thousand 376-pound barrels..	W	W	W	W	W	W	33,094	102,409
Clays.....short tons..	W	W	W	W	825,731	W	6,334,706	8,581
Lime.....do....	0	0	W	W	W	W	3,550,076	38,013
Natural gas.....million cubic feet..	2/30,596	$5,488	42,701	$8,445	91,071	W	602,310	116,766
Natural gas liquids.....thousand barrels..	19	66	198	452	2,850	W	8,495	17,430
Petroleum.....do....	2/10,152	29,710	12,788	39,303	21,393	$70,374	200,899	634,739
Salt.....thousand short tons..	W	W	W	W	W	W	32,043	101,968
Sand and gravel.....do....	2,838	2,523	3,996	3,873	5,525	W	49,166	47,602
Stone.....do....	41	41	0	0	0	0	44	45
Total.....		46,174		69,468		130,270		1,068,967

W Withheld to avoid disclosing company confidential information.
1/ Less than 1/2 unit.
2/ Estimated.

Projections for individual minerals and summaries for the years 1980, 2000, and 2020 are listed in table 33. Data are projected in the specific unit of production for each of the minerals, and all values are in terms of 1967 dollars.

Projections of Water and Land Needs

Mineral industry water needs in WRPA 8 amounted to about 31,200 acre-feet of diversions and 8,300 acre-feet of depletions in 1969. Diversions are projected to increase to 126-165 thousand acre-feet by 2020, a 300-430 percent increase. Depletions are expected to rise to 39-49 thousand acre-feet for a 370-490 percent increase.

Projections of water diversions and depletions for the production of individual mineral commodities and summary totals for the years 1980, 2000, and 2020 are listed in table 34.

Land use by mineral industry in WRPA 8 is minor. In 1969, an estimated total of 3,750 acres was used. By 2020, land use could reach 7,800-9,400 acres, about a 110-150 percent increase.

Projections of estimated land needs for the production of listed minerals and summaries for the years 1980, 2000, and 2020 are listed in table 35.

Table 33 - WRPA 8, Mineral Production and Value, 1969, and Projections for 1980, 2000, and 2020
(Thousand 1967 dollars adjusted by Bureau of Mines price indexes for selected minerals)

Commodity, unit of production	Projection	1969		1980		2000		2020	
		Production	Value	Production	Value	Production	Value	Production	Value
Fuels:									
Natural gas.....million cubic feet..	Program-A.	91,071	W	112,000	$20,720	152,000	$28,120	191,000	$35,335
Do.....do....	Program-B.	91,071	W	133,000	24,605	211,000	39,035	287,000	53,095
Natural gas liquids.....thousand barrels..	Program-A.	2,850	W	3,500	8,750	4,800	12,000	6,000	15,000
Do.....do....	Program-B.	2,850	W	4,200	10,500	6,600	16,500	9,000	33,500
Petroleum.....do....	Program-A.	21,393	$66,318	28,700	88,970	42,200	130,820	55,700	172,670
Do.....do....	Program-B.	21,393	66,318	31,500	97,650	49,600	153,760	67,900	210,490
Summary, fuels.....	Program-A.	-	90,291	-	118,440	-	170,940	-	223,005
Do.....	Program-B.	-	90,291	-	132,755	-	209,295	-	286,085
Nonmetallic minerals:									
Cement:									
Masonry.....280-pound barrels..	Program-A.	W	W	63,080	179	76,320	216	95,380	270
Do.....do....	Program-B.	W	W	66,960	189	84,440	239	108,040	306
Portland.....thousand 376-pound barrels..	Program-A.	W	W	2,130	6,667	2,580	8,075	3,220	10,079
Do.....do....	Program-B.	W	W	2,260	7,074	2,850	8,920	3,650	11,424
Clays.....thousand short tons..	Program-A.	826	W	945	1,125	1,196	1,423	1,535	1,827
Do.....do....	Program-B.	826	W	1,020	1,214	1,340	1,595	1,742	2,073
Lime.....short tons..	Program-A.	W	W	459,570	5,354	556,280	6,775	713,680	8,693
Do.....do....	Program-B.	W	W	474,130	5,775	623,080	7,589	809,970	9,865
Salt.....thousand short tons..	Program-A.	W	W	7,690	28,453	16,770	62,049	26,080	99,826
Do.....do....	Program-B.	W	W	8,440	31,228	20,750	76,775	34,670	128,279
Sand and gravel.....do....	Program-A.	5,525	W	6,326	6,389	8,006	8,086	10,271	10,374
Do.....do....	Program-B.	5,525	W	6,823	6,891	8,967	9,057	11,657	11,774
Stone.....do....	Program-A.	0	0	1	1	1	1	1	1
Do.....do....	Program-B.	0	0	1	1	2	2	2	2
Summary, nonmetallic minerals.....	Program-A.	-	35,366	-	48,168	-	86,625	-	131,070
Do.....	Program-B.	-	35,366	-	52,372	-	104,177	-	163,723
Total, all minerals.....	Program-A.	-	125,657	-	166,608	-	257,565	-	354,075
Do.....	Program-B.	-	125,657	-	185,127	-	313,472	-	449,808

W Withheld to avoid disclosing company confidential information.

Table 34 - WRPA 8, Projections of Mineral Production and Water Needs, 1960, 1980, 2000, and 2020

Commodity, unit of production	Projection	1960			1980			2000			2020		
		Production	Water needs, acre-feet		Production	Water needs, acre-feet		Production	Water needs, acre-feet		Production	Water needs, acre-feet	
			Diversion	Depletion		Diversion	Depletion		Diversion	Depletion		Diversion	Depletion
Fuels:													
Natural gas.....million cubic feet..	Program-A.	91,471	(1)	(1)	112,000	(1)	(1)	152,000	(1)	(1)	191,000	(1)	(1)
do....	Program-B.	91,471	(1)	(1)	133,000	(1)	(1)	211,000	(1)	(1)	287,000	(1)	(1)
Natural gas liquids.....thousand barrels..	Program-A.	2,850	10,685	661	3,500	13,122	812	4,800	17,985	1,113	6,000	22,494	1,391
do....	Program-B.	2,850	10,685	661	4,200	15,746	974	6,600	24,743	1,531	9,000	33,741	2,087
Petroleum:													
Production.....do....	Program-A.	21,393	(1)	(1)	28,700	(1)	(1)	42,200	(1)	(1)	55,700	(1)	(1)
do....	Program-B.	21,393	(1)	(1)	31,500	(1)	(1)	49,600	(1)	(1)	67,400	(1)	(1)
Drilling.....thousand feet..	Program-A.	1,149	271	271	1,406	363	363	2,068	534	534	2,729	704	704
do....	Program-B.	1,149	271	271	1,344	308	308	2,430	627	627	3,357	858	858
Secondary recovery2/...thousand barrels..	Program-A.	8,557	2,657	2,635	14,350	4,436	4,418	29,120	8,942	8,966	48,960	15,047	14,921
do....	Program-B.	8,557	2,657	2,635	15,750	4,800	4,840	34,220	10,625	10,556	59,070	18,341	18,188
Summary, fuels.....	Program-A.	-	13,613	3,567	-	17,941	5,593	-	27,571	10,613	-	38,245	17,016
do....	Program-B.	-	13,613	3,567	-	21,054	6,221	-	35,995	12,694	-	52,940	21,133
Nonmetallic minerals:													
Cement:													
Masonry.....280-pound barrels..	Program-A.	W	34	15	63,080	37	16	76,320	44	19	93,380	56	24
do....	Program-B.	W	34	15	66,060	39	17	84,140	49	21	108,040	63	27
Portland....thousand 376-pound barrels..	Program-A.	W	1,159	497	2,130	1,242	532	2,580	1,504	645	3,250	1,877	805
do....	Program-B.	W	1,159	497	2,260	1,318	565	2,850	1,662	712	3,630	2,128	912
Clays.....short tons..	Program-A.	825,231	377	43	945,160	482	49	1,196,480	547	62	1,535,030	702	91
do....	Program-B.	825,231	377	43	1,039,780	466	53	1,340,160	612	70	1,741,130	796	91
Lime.....short tons..	Program-A.	W	17	17	457,300	20	20	556,280	25	25	713,680	32	32
do....	Program-B.	W	17	17	474,130	21	21	623,080	28	28	809,970	36	36
Salt.....thousand short tons..	Program-A.	W	14,706	3,530	7,090	15,885	5,660	16,270	51,652	12,350	26,180	83,098	19,860
do....	Program-B.	W	14,706	3,530	9,440	25,905	6,210	20,750	63,910	15,280	34,670	106,784	25,520
Sand and gravel.....do....	Program-A.	5,525	1,208	676	6,820	1,585	774	8,006	1,760	980	10,271	2,248	1,357
do....	Program-B.	5,525	1,208	676	6,823	1,492	855	8,067	1,960	1,098	11,657	2,548	1,427
Stone.....do....	Program-A.	0	0	0	1	1	0	1	1	1	1	1	0
do....	Program-B.	0	0	0	1	1	0	2	1	1	2	1	0
Summary, nonmetallic minerals.....	Program-A.	-	17,561	4,778	-	26,800	7,051	-	55,525	14,081	-	88,011	22,058
do....	Program-B.	-	17,561	4,778	-	29,332	7,701	-	68,222	17,269	-	112,356	28,015
Total, all minerals.....	Program-A.	-	31,174	8,345	-	44,741	12,644	-	83,096	24,694	-	126,256	39,074
do....	Program-B.	-	31,174	8,345	-	50,386	13,922	-	104,217	29,963	-	165,296	49,148

W Withheld to avoid disclosing company confidential information.
1/ No significant water use.
2/ Assume 40 percent of production is by secondary recovery in 1960, 50 percent in 1980, 69 percent in 2000, and 87 percent in 2020.

Table 35 - WRPA 8, Projections of Land Use Needs for Mineral Resources, Acres

Commodity	Projection	1969	1980	2000	2020
Fuels.....	Program-A.	850	1,100	1,500	2,000
Do.....	Program-B.	850	1,300	2,000	2,700
Nonmetallic minerals....	Program-A.	2,900	3,400	4,400	5,800
Do.....	Program-B.	2,900	3,600	5,050	6,700
Total, all minerals.....	Program-A.	3,750	4,500	5,950	7,800
Do.....	Program-B.	3,750	4,900	7,050	9,400

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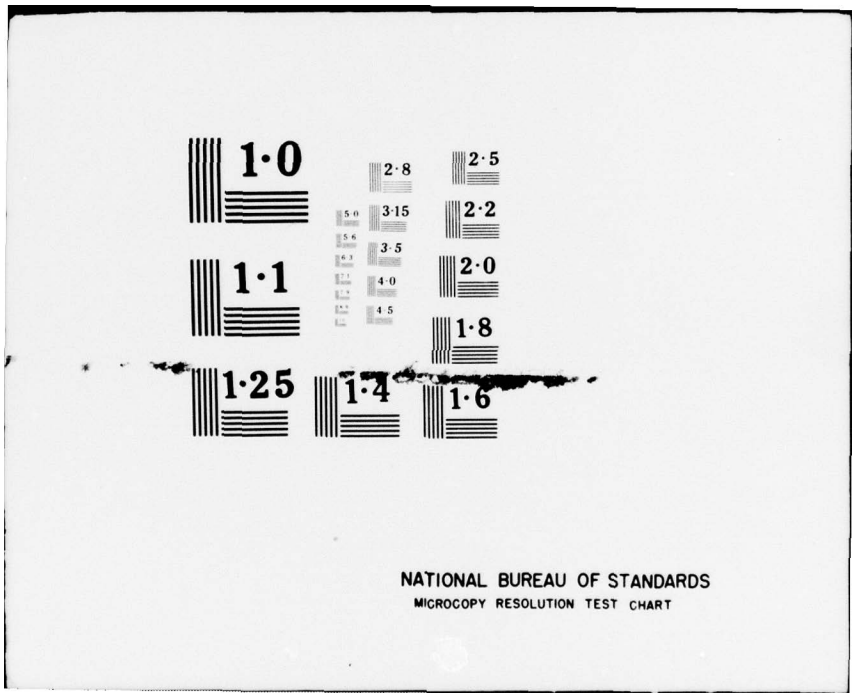
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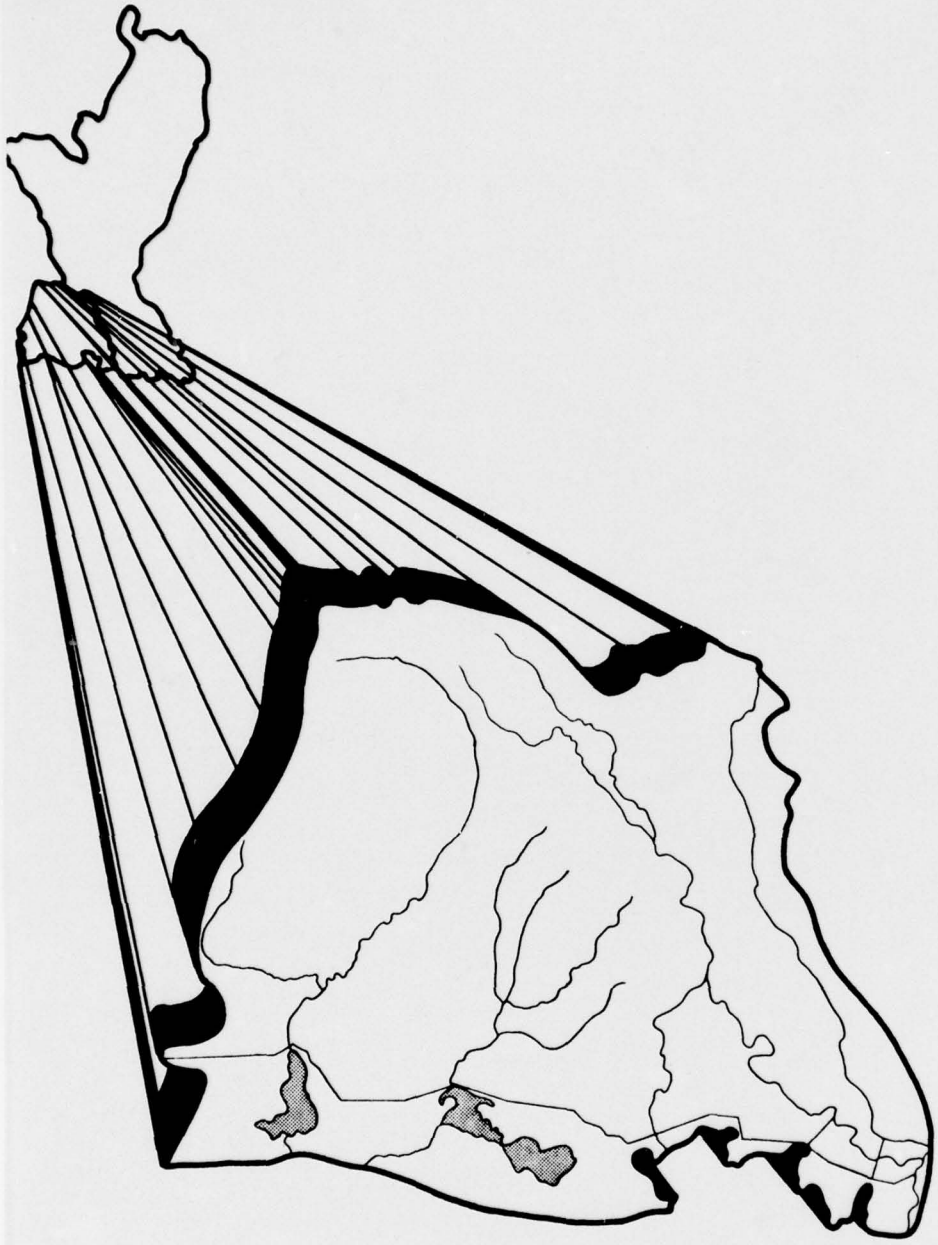


WRPA 9

W R P A 9

MINERAL RESOURCE BASE

WRPA 9 in southwest Louisiana is bordered by the Gulf of Mexico on the south, Texas on the west, and out-of-area Louisiana parishes on the north and east. The 14 Louisiana parishes within the area are as follows:

Acadia	Evangeline	St. Landry
Allen	Iberia	St. Martin
Beauregard	Jefferson Davis	St. Mary
Calcasieu	Lafayette	Vermillion
Cameron		Vernon

Mineral fuels or nonmetallic minerals are produced in all parishes in the area. The resource base of fuels and nonmetallic minerals generally is assumed to be sufficient to support the projections of mineral production through the year 2020. There are no known metallic deposits of economic significance in the area.

Mineral Fuels

Crude oil and natural gas have been produced in all parishes except Vernon Parish during the late 1960's. Offshore production has become particularly important in recent years.

Petroleum

During the 1956-69 interval, about 27 percent of the oil produced in the region was recovered in WRPA 9. If a similar share of the regional resource is assumed to exist in the area, WRPA 9 would still possess about 37 billion barrels of oil (table 3). Cumulative output through 2020 would be somewhat more than 18 billion barrels at the high rate of production, well within the estimated resource.

Natural Gas

WRPA 9 has been the leading producer of natural gas in the Lower Mississippi Region in the late 1960's. Value of output was about equal to that of petroleum in the area.

Approximately 53 percent of the region's natural gas output was recovered from WRPA 9 during the 1956-69 interval. Assuming a parallel share of the resource base, the area would have about 328 trillion cubic feet of gas remaining (table 3). Total gas production through 2020 at the estimated high rate of output would be about 310 trillion cubic feet. The resource base, then, appears to be quite tight; a more optimistic view probably would be apparent, however, if offshore potential was fully considered.

Nonmetallic Minerals

Salt

Resources of salt in WRPA 9 are virtually unlimited. Of the 88 known salt domes in the area (43 onshore and 45 offshore), salt volumes have been published for only 37 domes (27 onshore and 10 offshore). These 37 have an estimated total volume of 146.2 cubic miles of salt at depths less than 10,560 feet. At the 1969 rate of production for the United States--about 0.0042 cubic miles (44 million short tons)--and assuming 50 percent recovery, the 37 domes could supply the Nation's needs for 17,000 years.

Sand, Gravel, Clay, and Stone (Shell)

Sand, gravel, clay, and stone (shell) resources are virtually unlimited within WRPA 9. Moreover, most of these minerals are replenished. Quality problems exist, but, nevertheless, the resource base is quite adequate.

Sulfur

It is estimated that sulfur reserves in salt domes in Louisiana, including reserves offshore and that sulfur recovered from oil and gas production, total approximately 130 million long tons. It is not known what portion of this can be attributed to WRPA 9, but of the 183 known salt domes in Louisiana (116 onshore and 67 offshore), 88 are in WRPA 9. On this basis, about 62 million long tons of sulfur are in the area. Total projected production from 1969 to 2020 is 4.3 million long tons; therefore, the sulfur reserves are believed to be adequate.

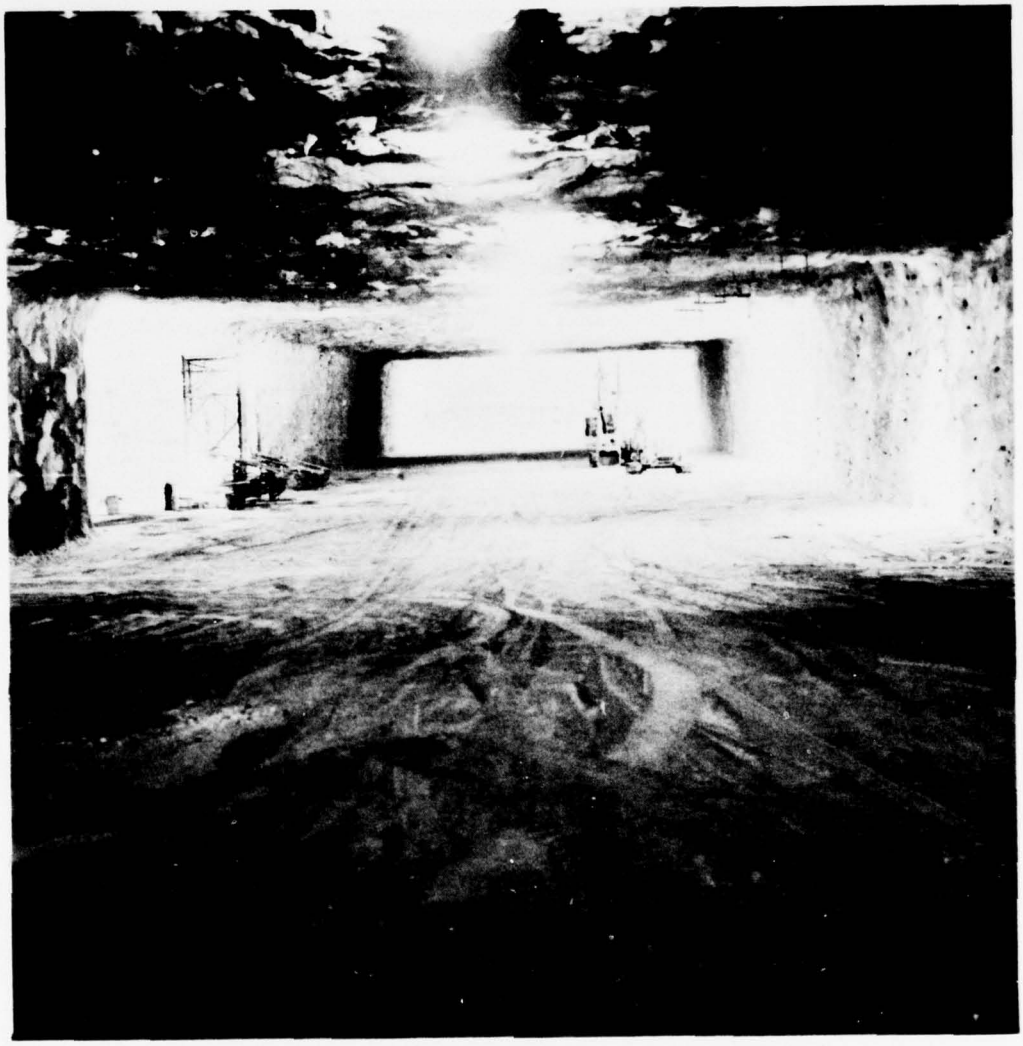
Cement and Lime

Cement and lime are traditionally listed with nonmetallic minerals. They are derived from the previously reviewed clay and shell minerals through a relatively simple manufacturing process. The resource base, again, is sufficient.

PRESENT MINERAL PRODUCTION

Mineral production in WRPA 9 historically has been dominated by the mineral fuels--petroleum, natural gas, and natural gas liquids. It is expected that this commanding position will prevail for many years; salt and sulfur, however, may exhibit more pronounced growth in output through 2020.

In 1969, total value of mineral production in WRPA 9 was $1.57 billion, about 33 percent of the $4.75 billion total value of mineral production in the Lower Mississippi Region. Mineral fuels accounted for $1.51 billion or 96 percent of WRPA 9 output, salt added 2.6 percent, and other nonmetallics made up the remaining 1.4 percent.



Underground salt mining in southern Louisiana.

The nonmetallic minerals produced in the area, with the exception of salt and sulfur, are construction commodities. Value of construction minerals, clay, lime, sand, gravel, and stone, totaled $13.8 million in 1969. With the closure of the Lone Star Cement Corp. plant at Lake Charles in April 1968, output of portland and masonry cement ceased in WRPA 9; it is assumed that because of general construction activity in the area, cement production will be resumed in the near future.

There was no 1969 production of metallic minerals in WRPA 9.

Table 36 lists mineral production in the area by commodity, unit of production, quantity, and value (in current dollars) for the years 1956, 1963, and 1969, and summarizes quantity and value for the years 1956-69, inclusive.

PROJECTIONS OF MINERAL PRODUCTION AND RELATED WATER AND LAND NEEDS

Projections of Mineral Production

Mineral output in WRPA 9 is expected to increase markedly during the 1969-2020 interval. Projections indicate that the value of mineral fuels may increase from $1.48 billion in 1969 to the $3.26-3.73 billion range by 2020 (all in terms of 1967 dollars), which represents an advance of about 120- to 150-percent. Value of nonmetallics output may rise from the $57 million level in 1969 to the $265-336 million range by 2020, an increase of 365- to 490-percent. Total value of mineral production, therefore, is projected to grow from $1.53 billion to $3.53-4.07 billion, a 130- to 165-percent increase during the period.

Projection data for individual minerals and summaries for the years 1980, 2000, and 2020 are listed in table 37. Data are projected in the specified unit of production for each of the mineral commodities, and all values are in terms of 1967 dollars.

Projections of Water and Land Needs

Mineral industry in WRPA 9 diverted an estimated 305 thousand acre-feet of water and depleted 49 thousand acre-feet of this supply to record its 1969 output. Based upon foreseen increases in mineral production through 2020, diversions are expected to rise to about 1,160-1,230 thousand acre-feet, an increase of 280-300 percent. During the same 1969-2020 interval, depletions should climb to approximately 201-237 thousand acre-feet, an increase of 310-380 percent.

Table 36 - WRPA 9, Mineral Production, 1956, 1963, 1969, and Total 1956-1969
(Values in thousand current dollars)

Commodity, unit of production	1956		1963		1969		Total 1956 - 1969	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Cement:								
Masonry.....280-pound barrels..	0	0	149,741	$390	0	0	896,268	$2,327
Portland.....thousand 376-pound barrels..	0	0	1,205	3,484	0	0	11,356	33,477
Clays.....short tons..	W	W	W	W	W	W	W	W
Lime.....do....	W	W	W	W	W	W	W	W
Natural gas.....million cubic feet..	894,576	$101,981	1,960,491	388,177	3,612,924	W	27,671,457	4,941,279
Natural gas liquids.....thousand barrels..	12,565	38,200	30,598	69,213	65,412	W	459,924	1,053,424
Petroleum.....do....	98,287	288,187	138,134	431,284	206,017	$680,851	1,996,900	6,297,728
Salt.....thousand short tons..	2,365	13,973	3,422	22,301	6,081	40,921	53,639	332,940
Sand and gravel.....do....	W	W	2,122	3,255	2,437	3,630	26,091	39,586
Stone (shell).....do....	W	W	W	W	W	W	20,490	35,875
Sulfur, Frasch.....thousand long tons..	W	W	0	0	21	576	608	14,692
Total.....		452,491		923,622		1,568,542		12,797,186

W Withheld to avoid disclosing company confidential information.

Table 37 - WRPA 9, Mineral Production and Value, 1969, and Projections for 1980, 2000, and 2020
(Thousand 1967 dollars adjusted by Bureau of Mines price indexes for selected minerals)

Commodity, unit of production	Projection	1969		1980		2000		2020	
		Production	Value	Production	Value	Production	Value	Production	Value
Fuels:									
Natural gas.....million cubic feet..	Program-A..	3,613,000	W	4,498,000	$837,000	6,041,000	$1,116,000	7,576,000	$1,496,000
Do.....do....	Program-B..	3,613,000	W	4,816,000	892,800	6,724,000	1,246,200	8,455,000	1,562,400
Natural gas liquids.....thousand barrels..	Program-A-B	65,412	W	103,024	256,470	170,006	423,300	238,054	592,620
Petroleum.....do....	Program-A..	206,017	$642,720	251,950	786,240	332,099	1,035,840	407,014	1,272,960
Do.....do....	Program-B..	206,017	642,720	275,033	858,000	393,080	1,226,160	505,978	1,578,720
Summary, fuels.....	Program-A..	-	1,475,166	-	1,879,710	-	2,575,140	-	3,260,580
Do.....	Program-B..	-	1,475,166	-	2,007,270	-	2,895,660	-	3,733,740
Nonmetallic minerals:									
Cement:									
Masonry.....280-pound barrels..	Program-A..	0	0	92,700	236	103,000	263	118,700	305
Do.....do....	Program-B..	0	0	99,000	252	118,800	303	139,500	356
Portland.....thousand 376-pound barrels..	Program-A..	0	0	1,030	2,966	1,150	3,312	1,330	3,850
Do.....do....	Program-B..	0	0	1,100	3,168	1,320	3,802	1,550	4,464
Clays.....short tons..	Program-A..	W	W	154,500	179	172,500	200	199,500	231
Do.....do....	Program-B..	W	W	165,000	191	198,000	230	232,500	270
Lime.....do....	Program-A..	W	W	340,400	4,280	390,000	4,778	451,000	5,525
Do.....do....	Program-B..	W	W	373,100	4,570	447,700	5,484	525,700	6,440
Salt.....thousand short tons..	Program-A..	6,981	41,816	11,200	67,088	24,430	146,336	39,300	235,407
Do.....do....	Program-B..	6,981	41,816	12,500	73,677	30,225	181,036	50,300	302,495
Sand and gravel.....do....	Program-A..	2,437	3,753	2,510	3,865	2,803	4,317	3,241	4,991
Do.....do....	Program-B..	2,437	3,753	2,681	4,129	3,217	4,954	3,777	5,817
Stone (shell).....do....	Program-A..	W	W	4,950	6,732	5,520	7,507	6,395	8,697
Do.....do....	Program-B..	W	W	5,289	7,195	6,547	8,632	7,455	10,136
Sulfur, Frasch.....thousand long tons..	Program-A-B	W	W	43	1,089	96	3,724	152	5,928
Summary, nonmetallic minerals.....	Program-A..	-	57,106	-	87,055	-	170,437	-	264,014
Do.....	Program-B..	-	57,106	-	94,869	-	208,165	-	335,906
Total, all minerals.....	Program-A..	-	1,532,272	-	1,966,745	-	2,745,577	-	3,525,494
Do.....	Program-B..	-	1,532,272	-	2,102,139	-	3,103,825	-	4,069,646

W Withheld to avoid disclosing company confidential information.

Projections of water needs--both diversions and depletions--for the production of individual mineral commodities and summary totals for the years 1980, 2000, and 2020 are listed in table 38.

Land use by mineral industry in WRPA 9 is a relatively small part of total acreage in the area. In 1969, the approximately 6,500 acres being used was less than 0.1 percent of the total land area. Total land needs are expected to increase to about 23.6-25.6 thousand acres by 2020, a 260-290 percent escalation.

Projections of estimated land needs for the production of mineral fuels and nonmetallics, together with summaries for the years 1980, 2000, and 2020, are listed in table 39.

Table 38 - WRPA 0, Projections of Mineral Production and Water Needs, 1969, 1980, 2000, and 2020

Commodity, unit of production	Projection	1969			1980			2000			2020		
		Production	Water needs, acre-feet		Production	Water needs, acre-feet		Production	Water needs, acre-feet		Production	Water needs, acre-feet	
			Diversion	Depletion		Diversion	Depletion		Diversion	Depletion		Diversion	Depletion
Fuels:													
Natural gas.....million cubic feet..	Program-A..	3,613,000	(1)	(1)	4,498,000	(1)	(1)	6,041,000	(1)	(1)	7,576,000	(1)	(1)
Do.....do....	Program-B..	3,613,000	(1)	(1)	4,816,000	(1)	(1)	6,721,000	(1)	(1)	8,433,000	(1)	(1)
Natural gas liquids.....thousand barrels..	Program-A-B	65,412	243,185	15,186	103,024	380,147	23,886	170,006	637,330	39,423	238,034	892,262	55,192
Petroleum:													
Production.....do....	Program-A..	206,017	(1)	(1)	231,959	(1)	(1)	332,099	(1)	(1)	407,044	(1)	(1)
Do.....do....	Program-B..	206,017	(1)	(1)	275,033	(1)	(1)	393,080	(1)	(1)	505,978	(1)	(1)
Drilling.....thousand feet..	Program-A..	10,474	2,706	2,706	11,771	3,041	3,041	15,561	4,020	4,020	19,133	4,948	4,948
Do.....do....	Program-B..	10,474	2,706	2,706	12,868	3,324	3,324	18,355	4,742	4,742	23,741	6,133	6,133
Secondary recovery2/...thousand barrels..	Program-A..	82,407	50,061	25,478	125,980	59,715	38,059	229,148	108,616	70,807	354,885	168,215	109,766
Do.....do....	Program-B..	82,407	50,061	25,478	137,016	65,183	42,672	271,225	128,561	83,794	481,201	208,655	136,048
Summary, fuels.....	Program-A..	-	280,952	43,350	-	448,903	65,886	-	749,966	114,250	-	1,065,425	169,906
Do.....	Program-B..	-	280,952	43,350	-	484,654	69,882	-	770,633	127,959	-	1,107,080	197,373
Nonmetallic minerals:													
Cement3/:													
Masonry.....280-pound barrels..	Program-A..	0	0	0	92,700	54	23	103,000	60	26	119,700	70	30
Do.....do....	Program-B..	0	0	0	99,000	58	25	118,800	69	30	130,500	81	35
Portland.....thousand 376-pound barrels..	Program-A..	0	0	0	1,030	600	258	1,150	670	288	1,330	775	332
Do.....do....	Program-B..	0	0	0	1,100	641	275	1,320	770	330	1,550	904	388
Clays4/.....short tons..	Program-A..	W	5	0.5	134,500	68	8	172,500	76	9	199,500	88	10
Do.....do....	Program-B..	W	5	0.5	165,700	73	9	198,000	87	10	232,500	103	12
Lime.....do....	Program-A..	W	15	15	344,400	16	16	390,000	17	17	451,000	20	20
Do.....do....	Program-B..	W	15	15	375,100	17	17	447,700	20	20	525,700	23	23
Salt.....thousand short tons..	Program-A..	6,981	16,231	5,130	11,200	26,040	8,245	24,430	56,800	17,985	30,300	91,372	28,933
Do.....do....	Program-B..	6,981	16,231	5,130	12,300	28,598	9,055	30,223	70,268	22,257	50,500	117,412	37,178
Sand and gravel5/.....do....	Program-A..	2,157	233	208	2,510	348	307	3,803	613	343	5,241	709	396
Do.....do....	Program-B..	2,157	233	208	2,681	580	328	3,217	703	393	5,777	826	462
Stone (shelle).....do....	Program-A..	W	830	464	4,950	854	478	5,820	952	533	6,395	1,103	618
Do.....do....	Program-B..	W	830	464	5,280	913	511	6,347	1,095	613	7,453	1,286	720
Sulfur, Frasch.....thousand long tons..	Program-A-B	W	230	62	45	478	126	96	1,055	277	152	1,679	441
Summary, nonmetallic minerals.....	Program-A..	-	17,849	5,978	-	28,658	9,461	-	60,243	19,478	-	95,816	30,780
Do.....	Program-B..	-	17,849	5,978	-	31,364	10,346	-	74,067	23,930	-	122,314	39,259
Total, all minerals.....	Program-A..	-	304,801	49,328	-	477,561	75,347	-	810,209	133,728	-	1,161,241	200,686
Do.....	Program-B..	-	304,801	49,328	-	480,018	80,228	-	844,700	151,889	-	1,229,364	236,632

W Withheld to avoid disclosing company confidential information.
1/ No significant water use.
2/ Assume 40 percent of production is by secondary recovery in 1969, 50 percent in 1980, 69 percent in 2000, and 87 percent in 2020.
3/ On basis of past performance, assume, for projections, 1,000,000 barrels of portland cement and 90,000 barrels of masonry cement in 1969.
4/ Based on past performance, assume, for projections, 190,000 tons of clay in 1969.
5/ Assume 95 percent of production will be washed.
6/ Based on 1969 proportion of shell used as aggregate and road construction (75 percent). It is assumed that 75 percent of projected production is treated as sand and gravel for water needs.

Table 39 - WRPA 9, Projections of Land Use Needs for Mineral Resources, Acres

Commodity	Projection	1969	1980	2000	2020
Fuels.....	Program-A.	5,100	7,200	11,000	14,700
Do.....	Program-B.	5,100	7,500	11,600	15,600
Nonmetallic minerals.....	Program-A.	1,400	3,400	5,400	8,900
Do.....	Program-B.	1,400	3,500	6,000	10,000
Total, all minerals.....	Program-A.	6,500	10,600	16,400	23,600
Do.....	Program-B.	6,500	11,000	17,500	25,600

WRPA 10

W R P A 1 0

MINERAL RESOURCE BASE

WRPA 10 parishes surround the city of New Orleans in the southeast corner of the Lower Mississippi Region. This area is bordered by out-of-area parishes on the north and west, the Gulf of Mexico on the south and southeast, and by Mississippi on the northeast. The area is comprised of 11 parishes as follows:

Assumption	Plaquemines	St. James
Jefferson	St. Bernard	St. John
Lafourche	St. Charles	St. Tammany
Orleans		Terrebonne

All parishes have recorded petroleum and natural gas output in the 1960's. In 1968 and 1969, value of mineral production in Plaquemines Parish exceeded $1 billion--a unique statistic in the Nation. Petroleum, natural gas (both from onshore and offshore), and sulfur made up the bulk of this value. In 1969, only the value of mineral output in the States of Texas, California, and Oklahoma (as well as Louisiana) surpassed that of Plaquemines Parish. The area in recent years has produced about 60 percent of the Nation's sulfur. Salt is also produced, and a number of construction minerals are recovered for local use. The resource base for all minerals currently produced seems sound.

Mineral Fuels

Petroleum

Crude oil has been produced in prolific quantity in the area, and all parishes have contributed to output. Offshore production has become increasingly important in recent years.

During the 1956-69 period, WRPA 10 produced about 60 percent of the petroleum in the region. Assuming that a similar share of the total regional resource exists in the area, WRPA 10 would have about 82 billion barrels of crude oil remaining (table 3). Cumulative output through 2020 would be approximately 85 billion, essentially the same as the resource base. (Offshore potential probably is not fully indicated in the resource base.)

Natural Gas

Natural gas is second only to petroleum in the area, and the value of output has been on the order of one-third that of crude oil in recent years.

Production of natural gas in WRPA 10 amounted to about 38 percent of the regional total during 1956-69. Assuming this output is an indication of the resource potential, there would be approximately 235 trillion cubic feet of natural gas remaining (table 3). Total gas output through 2020 would be about 310 trillion cubic feet at the high level of production. This is considerably more gas than is estimated to exist in the area; therefore, without the benefit of offshore gas (not fully considered herein), it is apparent that a gas resource problem could materialize soon after 2000 in WRPA 10.

Nonmetallic Minerals

Clay, Lime, Sand, Gravel, and Stone (Shell)

Construction minerals are produced in most parishes in the area. Lime is produced in Orleans Parish and is used in manufacturing cement for regional needs. Quality of these minerals is variable and in places a troublesome factor; the area's resource base, however, seems ample to support projected output through 2020.

Salt

Salt is produced in Assumption, Jefferson, and Plaquemines Parishes. The resource base is immense.

Sulfur

Sulfur is produced in Jefferson, Lafourche, Plaquemines, and Terrebonne Parishes. Associated with the huge salt domes in the area, sulfur deposits are considerably less extensive and more difficult to recover. The resource base, however, is assumed to be capable of satisfying output projected through 2020.

PRESENT MINERAL PRODUCTION

Petroleum industry output of crude oil and natural gas (including natural gas liquids) makes up about 90-95 percent of the area's value of mineral production. Sulfur, salt, and cement contribute most of the remainder of mineral output. No metallic minerals are produced. In 1969, this 11-parish area comprised about 10 percent of the Nation's total value of mineral output.

Table 40 lists the mineral production in WRPA 10 by commodity, unit of production, quantity, and value (in current dollars) for the years 1956, 1963, and 1969, and summarizes quantity and value for the years 1956-69, inclusive.

Grand Isle sulfur mine, south of Jefferson Parish, La.

Table 40 - WRPA 10, Mineral Production, 1956, 1963, 1969, and Total 1956-1969
(Values in thousand current dollars)

Commodity, unit of production	1956		1963		1969		Total 1956 - 1969	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Cement:								
Masonry.....280-pound barrels..	W	W	0	0	W	W	763,488	$2,187
Portland.....thousand 376-pound barrels..	W	W	W	W	W	W	40,040	130,327
Clays.....short tons..	W	W	W	W	W	W	1,521,270	1,766
Lime.....do....	0	0	W	W	W	W	709,869	9,740
Natural gas.....million cubic feet..	453,078	$51,651	1,321,428	$261,643	2,961,152	W	19,812,904	3,577,782
Natural gas liquids.....thousand barrels..	1,422	3,022	7,510	17,100	30,002	W	150,992	349,472
Petroleum.....do....	141,925	416,140	314,474	981,857	565,880	$1,870,135	4,451,277	14,047,822
Salt.....thousand short tons..	0	0	0	0	660	2,441	3,440	12,730
Sand and gravel.....do....	388	481	W	W	3,781	4,058	12,728	13,574
Stone.....do....	2,688	4,085	2,031	2,690	W	W	33,147	45,591
Sulfur, Frasch.....thousand long tons..	W	W	2,445	48,905	3,978	107,723	40,016	1,055,779
Total.....		539,741		1,321,348		2,645,330		19,246,770

W Withheld to avoid disclosing company confidential information.

PROJECTIONS OF MINERAL PRODUCTION AND RELATED WATER AND LAND NEEDS

Projections of Mineral Production

Minerals output in WRPA 10 is projected to increase smartly through 2020, and assuming the offshore resource potential for natural gas (as well as crude oil and sulfur) proves to be favorable, the growth in mineral production could be extraordinary. Crude oil output should increase by as much as 385 percent through 2020, while gas production could be up 215 percent. Sulfur and salt output could increase as much as 500 and 625 percent, respectively. Nonmetallic minerals as a group in 1969 made up about 6 percent of the total value of mineral output, but by 2020 this group could represent as much as 10 percent of total value of output.

Projections for individual minerals and summaries for the years 1980, 2000, and 2020 are listed in table 41. Data are projected in the specific unit of production for each of the minerals, and all values are in terms of 1967 dollars.

Projections of Water and Land Needs

Mineral industry water needs in WRPA 10 amounted to about 259 thousand acre-feet of diversions and 95 thousand acre-feet of depletions in 1969. Diversions are projected to swell to 670-1,660 thousand acre-feet, a 160-540 percent increase. Depletions are expected to rise to 340-870 thousand acre-feet, a 260-800 percent increase.

Projections of water diversions and depletions for the output of individual commodities, together with summary totals for the years 1980, 2000, and 2020, are listed in table 42.

Land use by mineral industry in WRPA 10 is relatively significant when compared with mineral land use in the rest of the Lower Mississippi Region. It amounted to an estimated 14,050 acres in 1969, about 20 percent of mineral industry land use in the region. By 2020, land use could reach 29,450-57,450 acres for about an 110-310 percent increase. Land use in the area in 2020 would still hover about the 20 percent level of 1969.

Projections of estimated land needs for the production of listed mineral groups and summaries for the years 1980, 2000, and 2020 are listed in table 43.

Table 41 - WRPA 10, Mineral Production and Value, 1969, and Projections for 1980, 2000, and 2020
(Thousand 1967 dollars adjusted by Bureau of Mines price indexes for selected minerals)

Commodity, unit of production	Projection	1969		1980		2000		2020	
		Production	Value	Production	Value	Production	Value	Production	Value
Fuels:									
Natural gas.....million cubic feet..	Program-A.	2,961,152	W	3,033,000	$675,738	4,948,000	$920,328	6,221,000	$1,157,106
Do.....do....	Program-B.	2,961,152	W	4,325,000	804,078	6,867,000	1,277,262	9,328,000	1,735,008
Natural gas liquids.....thousand barrels..	Program-A.	36,002	W	41,200	102,588	49,100	122,259	57,600	143,424
Do.....do....	Program-B.	36,002	W	65,600	163,344	114,600	285,354	163,600	407,364
Petroleum.....do....	Program-A.	565,880	$1,765,546	667,200	2,081,664	841,500	2,625,480	1,029,900	3,215,288
Do.....do....	Program-B.	565,880	1,765,546	1,073,500	3,349,320	1,886,100	5,884,632	2,757,000	8,601,840
Summary, fuels.....	Program-A.	-	2,405,937	-	2,859,990	-	3,668,067	-	4,515,818
Do.....	Program-B.	-	2,405,937	-	4,316,742	-	7,447,248	-	10,744,212
Nonmetallic minerals:									
Cement:									
Masonry.....280-pound barrels..	Program-A.	W	W	111,400	260	134,800	314	168,495	393
Do.....do....	Program-B.	W	W	118,300	276	149,161	348	190,845	445
Portland.....thousand 376-pound barrels..	Program-A.	W	W	4,517	14,680	5,466	17,764	6,831	22,201
Do.....do....	Program-B.	W	W	4,796	15,587	6,047	19,653	7,737	25,145
Clays.....short tons..	Program-A.	W	W	175,700	225	221,600	281	283,600	360
Do.....do....	Program-B.	W	W	189,600	241	247,000	314	321,800	409
Lime.....do....	Program-A.	W	W	114,300	1,598	144,100	2,015	184,400	2,578
Do.....do....	Program-B.	W	W	123,300	1,724	160,700	2,247	209,300	2,926
Salt.....thousand short tons..	Program-A.	660	2,442	1,058	3,915	2,308	8,540	3,713	13,738
Do.....do....	Program-B.	660	2,442	1,162	4,299	2,855	10,564	4,771	17,653
Sand and gravel.....do....	Program-A.	3,781	4,310	4,350	4,959	5,500	6,270	7,050	8,037
Do.....do....	Program-B.	3,781	4,310	4,700	5,358	6,150	7,011	8,000	9,120
Stone.....do....	Program-A.	W	W	5,100	5,712	6,450	7,224	8,250	9,240
Do.....do....	Program-B.	W	W	5,500	6,160	7,200	8,064	9,350	10,472
Sulfur, frasch.....thousand long tons..	Program-A.	3,078	131,115	6,200	204,352	10,100	332,896	13,700	451,552
Do.....do....	Program-B.	3,078	131,115	8,550	281,808	16,200	533,952	23,800	784,448
Summary, nonmetallic minerals.....	Program-A.	-	158,346	-	255,699	-	375,304	-	508,099
Do.....	Program-B.	-	158,346	-	315,453	-	582,155	-	850,618
Total, all minerals.....	Program-A.	-	2,564,283	-	3,095,689	-	4,043,371	-	5,021,917
Do.....	Program-B.	-	2,564,283	-	4,632,195	-	8,029,401	-	11,594,830

W Withheld to avoid disclosing company confidential information.

Table 42 - WRPA 10, Projections of Mineral Production and Water Needs, 1960, 1980, 2000, and 2020

Commodity, unit of production	Projection	1960			1980			2000			2020		
		Production	Water needs, acre-feet		Production	Water needs, acre-feet		Production	Water needs, acre-feet		Production	Water needs, acre-feet	
			Diversion	Depletion		Diversion	Depletion		Diversion	Depletion		Diversion	Depletion
Fuels:													
Natural gas.....million cubic feet..	Program-A.	2,061,152	(1)	(1)	3,633,300	(1)	(1)	4,948,900	(1)	(1)	6,221,000	(1)	(1)
Do.....do....	Program-B.	2,061,152	(1)	(1)	4,325,900	(1)	(1)	6,867,000	(1)	(1)	9,838,000	(1)	(1)
Natural gas liquids.....thousand barrels..	Program-A.	30,002	134,371	8,349	41,200	134,434	8,354	49,100	184,076	11,380	57,600	215,844	13,357
Do.....do....	Program-B.	30,002	134,371	8,349	65,600	340,934	13,213	114,800	430,635	26,570	165,600	613,536	38,253
Petroleum:													
Production.....do....	Program-A.	565,880	(1)	(1)	667,200	(1)	(1)	841,500	(1)	(1)	1,020,000	(1)	(1)
Do.....do....	Program-B.	565,880	(1)	(1)	1,073,500	(1)	(1)	1,880,100	(1)	(1)	3,257,000	(1)	(1)
Drilling.....thousand feet..	Program-A.	12,114	3,122	3,122	15,693	4,051	4,051	19,792	5,108	5,108	24,623	6,344	6,344
Do.....do....	Program-B.	12,114	3,122	3,122	25,249	6,502	6,502	44,361	11,455	11,455	64,845	16,718	16,718
Secondary recovery2/...thousand barrels..	Program-A.	226,352	70,282	69,694	333,600	103,583	102,713	580,600	180,176	178,767	896,000	278,208	275,979
Do.....do....	Program-B.	226,352	70,282	69,694	530,800	166,676	165,281	1,301,800	404,085	400,701	2,598,000	744,453	794,220
Summary, fuels.....	Program-A.	-	208,375	81,165	-	262,068	116,720	-	360,460	193,261	-	500,594	295,470
Do.....	Program-B.	-	208,375	81,165	-	419,112	186,996	-	849,175	438,752	-	1,374,813	793,196
Nonmetallic minerals:													
Cement:													
Masonry.....280-pound barrels..	Program-A.	K	61	26	111,400	65	28	134,800	79	34	168,495	98	42
Do.....do....	Program-B.	K	61	26	118,300	69	30	143,161	87	37	180,843	111	48
Portland.....thousand 376-pound barrels..	Program-A.	A	2,477	1,854	4,417	2,633	1,120	5,466	5,187	1,366	6,831	5,082	1,708
Do.....do....	Program-B.	A	2,477	1,854	4,796	2,706	1,150	6,047	5,225	1,312	7,755	4,511	1,504
Clays.....short tons..	Program-A.	A	70	4	175,700	80	9	221,600	101	12	287,000	130	15
Do.....do....	Program-B.	A	70	4	180,600	87	10	247,000	115	13	321,800	147	17
Lime.....do....	Program-A.	A	4	4	114,300	5	5	144,100	6	6	184,400	8	8
Do.....do....	Program-B.	A	4	4	123,300	6	6	160,700	7	7	209,300	9	9
Salt.....thousand short tons..	Program-A.	660	2,053	436	1,158	3,230	778	2,308	7,180	1,699	3,713	11,456	2,734
Do.....do....	Program-B.	660	2,053	436	1,167	3,279	855	2,455	8,593	2,102	4,771	14,605	3,512
Sand and gravel.....do....	Program-A.	1,741	827	463	4,350	951	532	5,300	1,201	673	7,050	1,541	863
Do.....do....	Program-B.	1,741	827	463	4,700	1,027	573	6,150	1,344	733	8,200	1,792	979
Stone.....do....	Program-A.	A	968	541	5,100	1,115	624	6,450	1,411	790	8,150	1,783	1,017
Do.....do....	Program-B.	A	968	541	5,800	1,267	673	7,200	1,574	881	9,260	2,041	1,144
Sulfur, Frasch.....thousand long tons..	Program-A.	3,978	43,929	11,552	6,200	68,467	17,974	10,100	111,534	29,280	15,730	151,709	39,716
Do.....do....	Program-B.	3,978	43,929	11,552	8,530	94,416	24,780	16,200	178,805	46,964	25,830	262,823	68,996
Summary, nonmetallic minerals.....	Program-A.	-	50,349	14,115	-	76,573	21,080	-	124,028	33,850	-	179,287	48,996
Do.....	Program-B.	-	50,349	14,115	-	105,184	28,131	-	194,140	52,260	-	286,089	76,659
Total, all minerals.....	Program-A.	-	258,724	95,280	-	338,668	137,490	-	484,488	227,120	-	679,881	344,475
Do.....	Program-B.	-	258,724	95,280	-	524,296	215,130	-	1,043,315	491,001	-	1,660,908	869,855

K - Withheld to avoid disclosing company confidential information.
1/ No significant water use.
2/ Assume 40 percent of production is by secondary recovery in 1960, 50 percent in 1980, 60 percent in 2000, and 67 percent in 2020.

Table 43 - WRPA 10, Projections of Land Use Needs for Mineral Resources, Acres

Commodity	Projection	1969	1980	2000	2020
Fuels	Program-A.	7,950	9,500	11,900	14,550
Do.	Program-B.	7,950	14,550	25,200	36,350
Nonmetallic minerals	Program-A.	6,100	7,850	11,200	14,900
Do.	Program-B.	6,100	9,300	14,950	21,100
Total, all minerals	Program-A.	14,050	17,350	23,100	29,450
Do.	Program-B.	14,050	23,850	40,150	57,450

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